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POWER

Power Generation, Transmission, Application and Attendant Services in all Industries

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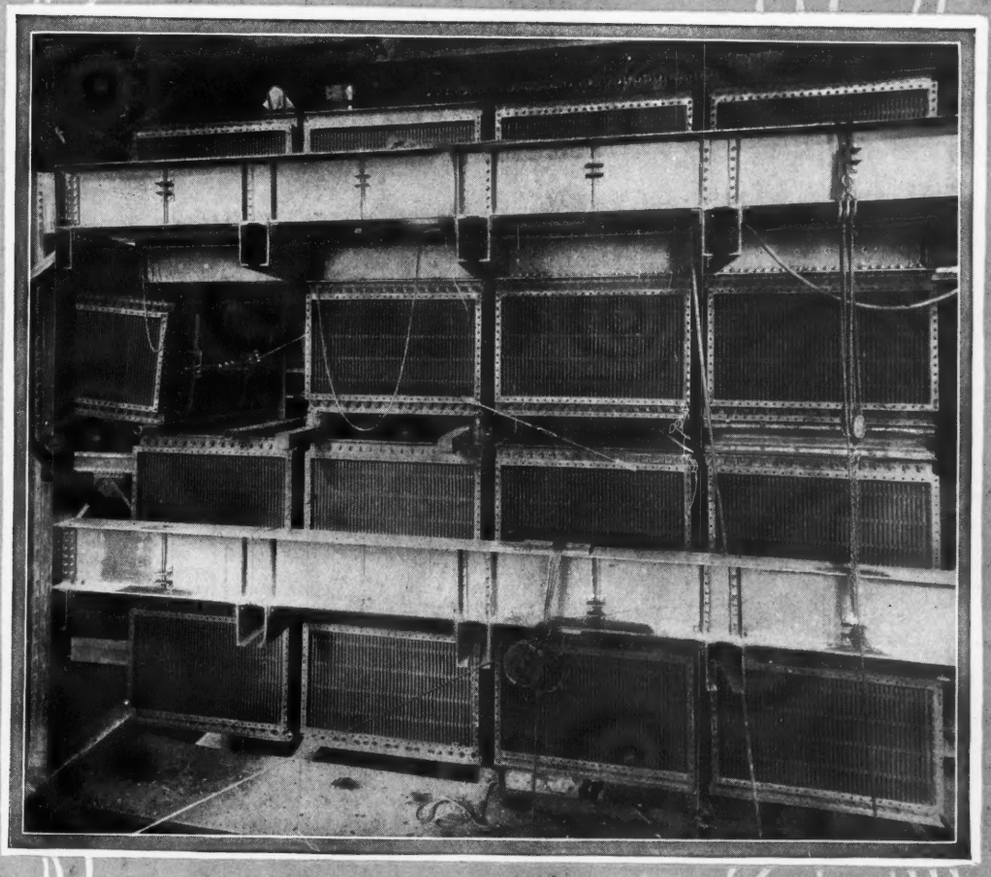

Foster Sectional Air Preheater

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A description of this air heater is given on page 23.

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METERED COMBUSTION CONTROL

Flexibility—unusual flexibility—is an outstanding feature of L & N Metered Combustion Control.

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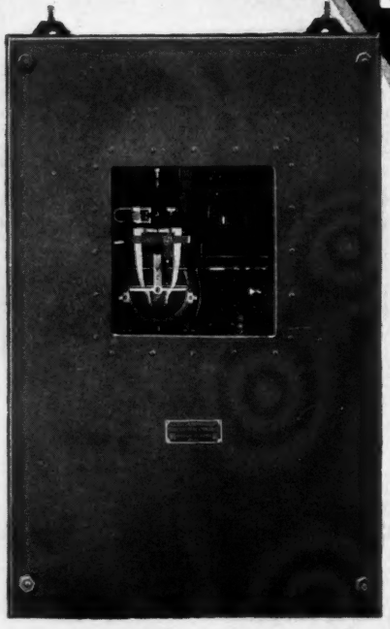

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POWER

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Volume 69 Number 14

April 2, 1929

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Triple Acting also Non-Return Valves

1. Automatically cut out the boiler the instant that a tube rupture or other internal break occurs.
2. Automatically cut off the steam flow from every boiler the instant that a steam pipe breaks.
3. Automatically equalize the pressure between all boilers.
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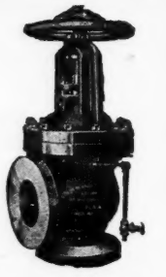
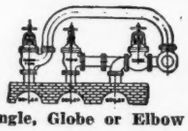
7. The only valve that can be tested in service from boiler room floor.
8. Double Corliss Dash Pot that cushions in opening and closing.
9. Cannot pound, spin, stick or chatter.
10. By disconnecting pilot valve, the triple acting style can be changed into plain non-return.

"Heaviest Valves Made"





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Double Corliss Dash Pots with Enormous Area Insuring Most Positive Cushioning.

Dash Pots Sealed and Cut Off Current of Steam Flow so that Grit or Scale Cannot Bind or Stick Valves.

Most Positive and Dependable Valves Made for Life and Property Protection.

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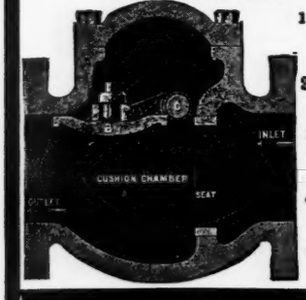
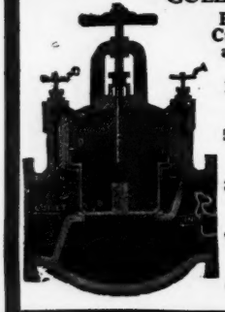
Pat. Automatic Cushioned Swing Check Valves



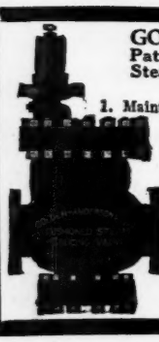
1. Especially adapted for water service.
2. For high or low pressure.
3. For vertical or horizontal lines.
4. Ideal Bleeder Valve.
5. Sizes to 24 in.

GOLDEN-ANDERSON
Pat. Automatic Cushioned Check and Hand Stop Valve



1. Adapted for water service and boiler feed lines.
2. Always cushioned in opening and closing.
3. Quickly regulated for fast or slow closure.
4. No water hammer or shock any time.
5. Sizes 3-in. to 24-in. inclusive.

GOLDEN-ANDERSON
Pat. Automatic Cushioned Steam Pressure Reducing Valves



1. Maintain a constant reduced pressure.
2. Thoroughly cushioned.
3. No hammering, chattering or sticking.
4. No auxiliary valves or small by-passes to clog up.
5. No wire drawing.
6. Only one adjustment from the outside.
7. Double extra heavy throughout — practically indestructible.

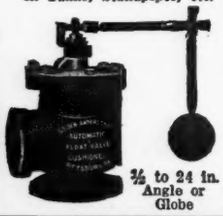
Now Our Water System Will Never Be Interrupted—

Thanks to Our GOLDEN-ANDERSON
Pat. Cushioned Automatic Controlling Altitude Valves

1. Automatically maintain uniform water levels in tanks, standpipes, reservoirs, etc.
2. For high or low pressure. Always dependable.
3. No floats or fixtures used.
4. No water hammer or shocks.
5. Sizes up to 24 in.

GOLDEN-ANDERSON
Pat. Automatic Cushioned Water Float Valve

1. Automatically Maintain Uniform Water Levels in Tanks, Standpipes, etc.



½ to 24 in. Angle or Globe

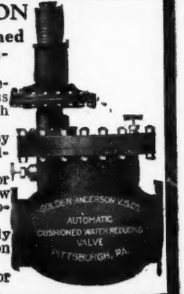
2. Instantly Adjusted to Operate Quickly or Slowly.
3. Floats Swivel to any Angle — Most Satisfactory Float Valves known.
4. No Metal-to-metal Seats — No Water Hammer or Shock.
5. Cushioned by Water and Air.

GOLDEN-ANDERSON
Pat. Automatic Cushioned Controlling Float Valve

1. Automatically maintains uniform level in heaters, tanks, etc.
2. Air and water cushioned.
3. No metal-to-metal seat.
4. No waste of water.
5. No water hammer shock.
6. Angle or Globe patterns to 24 in.

GOLDEN-ANDERSON
Pat. Automatic Cushioned Water Pressure Regulating Valves

1. Maintain a constant reduced pressure regardless of fluctuations on high pressure side.
2. Perfectly Cushioned by water and air. No metal-to-metal seats.
3. The best valve made for maintaining a constant low pressure where consumption is continuous.
4. Operates quickly or slowly as required—No attention necessary.
5. Positively no hammering or sticking. Sizes to 24 in.



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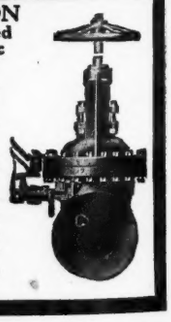
Pat. Cushioned Combined Throttle and Automatic Engine Stop Valves

1. Operate 3 ways: Automatically, by Hand, or by Electric Switch.
2. Prevent Flywheel Explosions.
3. "Double Corliss" Cushioned—No Pounding or Sticking.
4. Contain No Tight Fitting Parts.
5. Furnished in Angle and Globe Patterns for High or Low Pressures.
6. "Always Ready for Service."



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POWER

FRED R. LOW, *Editor*

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Volume 69 New York, April 2, 1929 *Number 14*

Powdered-Coal Explosions

THE use of powdered coal has been marred by several destructive explosions, mostly in the earlier days of its history.

Powdered coal is explosive only in the sense that flour is explosive. There have been many disastrous explosions of flour and other finely comminuted combustible substances in mills and factories.

But powdered coal is not explosive in a compact mass. You can no more touch off a barrel or a pile of powdered coal than you can a barrel of flour.

They are different from powder and other solid explosives in that such explosives have in their own composition the materials which by their combination produce their instantaneous combustion, whereas the coal, flour, etc., have to get the oxygen for their combustion from the atmosphere.

Highly volatile liquid combustibles like benzine are explosive because by their rapid vaporization they produce explosive mixtures with the surrounding air.

If one could live in the interior of a gas holder he could strike a match or draw an electric arc without exploding the contents if there were no oxygen present.

Explosion is merely very rapid combustion and an explosion of coal or other dust is possible only when the material is not only finely pulverized but is so diffused that the oxygen of the air can get to each particle with explosive rapidity.

You can hold a lighted match to a dry log without setting it afire but it will quickly light a pile of shavings.

I used to have, for use in lectures on combustion, a strand of steel wire or wool, drawn so fine that it would burn when held in a flame.

There need be no more fear of an explosion in a pulverized-coal plant than in a flour mill if care is taken to prevent the diffusion of the coal-dust in the atmosphere so as to make an explosive mixture.

This involves not only the avoidance of leaks in the pulverizing, storing and conveying apparatus, but the prevention of dust accumulations on beams or elsewhere whence it may be blown or jarred into a cloud that may be fired by a spark or flame. It must not, of course be poured or shoveled in the open so that such a cloud may be raised.

F. R. Low

POWER *Stands for . . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**

Loyalty Still Pays

TALK to an up-to-date member of the younger generation about loyalty and derision will be your meed. In the terse and expressive phrase of the day, "loyalty is out." He who advocates this virtue, whether toward country, family or employer, is immediately classed as old-fashioned and relegated to that limbo for dusty antiques which already holds the puritan and the patriot.

Yet, in spite of this challenge from those who are about to take over control of the world's affairs, loyalty still has its values. Consider, for instance, the relations between the engineer and his employer. In days gone by, engineers were prone to stick to one employer through all his ups and downs. This quality, combined with the necessary brains and ability, has borne fruit. Many who started years ago with little training and no money are now the heads of great undertakings. And their loyalty to the companies they served has been no small factor in their advance.

The Vanishing Cost Handicap of High Pressures

"WHAT counts is dollar economy, not B.t.u. economy"; the expression is commonly heard these days wherever engineers meet. Here is a truth that cannot be over-emphasized as long as the dollar is forgotten in the exciting chase of the elusive B.t.u. But objections should be voiced to the frequent misuse of this slogan. It is too often assumed that higher B.t.u. economy necessarily involves higher charges. This assumption continually crops up in the discussion of higher steam pressures, where its justification is rapidly disappearing.

Opponents of higher steam pressures grant substantial fuel savings, but ask whether they are worth the "additional cost of the high-pressure plant." Apparently those who ask this are haunted by the high cost of forged boiler drums, thick tubes and large multistage feed pumps. They forget that only a small part of the high-pressure plant is "high-pressure." Obviously, the land and buildings are not "high-pressure." Nor are the condensers, coal- and ash-handling equipment, stacks, fans, and most of the other items of the station equipment. Where the cost of these items is affected at all, it is actually reduced by high pressures. Reduced fuel consumption means a saving at every step of the fuel-burning process from coal handling to stacks and ash disposal —and a small boiler house. Less steam per kilowatt-hour means smaller condensers, with a saving in circulating pumps and buildings.

That these savings are not imaginary is proved by the consistent testimony of those most familiar with the construction and operation of high-pressure condensing stations. An additional cost of eight dollars per kilowatt is about the highest estimate yet received from such a source. The average report is nearer four dollars, and we have Mr. Moultrop's word for it that a complete high-pressure station intelligently designed need not cost a penny more than a station to operate under so-called normal pressure. This, remember, is with present costs of high-pressure equipment. Is it not reasonable to expect a substantial decrease in the cost of high-pressure boilers and turbines when they are produced in greater quantities?

The time is apparently not far distant when a high-pressure condensing station will actually cost less than one for normal pressures. All talk about load factors, and B.t.u. versus dollars, will then become meaningless patter as far as this problem is concerned. With the bogey of "danger" already laid and that of unreliability headed for the same grave, it will soon be hard to find any good excuse for not installing high pressures in condensing stations.

By an entirely different line of reasoning, because the situation is entirely different, it can be shown that the large industrial power plant with relatively high demand for byproduct power has even more to gain than the central stations from high pressures. A start has been made in this field, and we may expect rapid developments on the heels of the pioneer work done by the central stations and a few of the great process industries.

"Wanted: An Unpractical Education"

"I HAVE a son who is nearly thirteen years old. . . . I hope he can be given through the years of high school and college the sort of thing that is commonly called an 'unpractical education'. . . . I know perfectly well that his young mind will absorb only a certain amount and that if particular training in a too narrowly defined art be given him, life may perpetrate one of its ghastly jokes in presenting narrow opportunity along that line and big opportunities in fields for which he has not been trained at all. . . . If he elects to take a course in engineering, I hope that he will bring out of it a knowledge of the conduct and behavior of materials and of the processes by which industrial human progress has taken place. . . . I shall not, however, be very much concerned with whether he has been taught some particular form of valve gear or somebody's pet formula for buttoning up a riveted joint. . . .

"The ink will not have time to dry on the student's diploma before the quantitative facts, social emphasis and the problems that are crying for solution shall have changed. . . . Let it be thoroughly understood, too, that the teaching of practice may be the teaching of obsolete or bad things. All practice contains some elements that are not worthy to be continued, and some practice is positively wrong. . . . The teaching of practice tends to the continuation of evils rather than to the type of mind that makes for betterments. . . . What little of practical training may be necessary can very quickly be grasped by a young man fundamentally and thoroughly educated, through his contacts in the only school of practice—life itself."

These are not the words of a cloistered recluse. Rather is their author an engineering executive in constant touch with the stern realities of power generation and distribution—John C. Parker, vice-president in charge of engineering, Brooklyn Edison Company. The sentences quoted are culled from a recent address to members of the Society for the Promotion of Engineering Education.

Leaders of industry and education alike are swinging more and more to this viewpoint. They begin to see that a mastery of fundamental principles with some practice in their application, plus health, character and enthusiasm, must be the goal of real engineering education. Thus equipped, the graduate can grapple with and eventually conquer almost any problem he may meet.

Carbon Brush Standardization

THERE are three groups concerned with the proposal to standardize carbon brushes: The brush manufacturers, the machine builders, and the users. What the lack of proper standards means to brush manufacturers is indicated by the fact that there are in use on electric machines about one-half million styles of carbon brushes of different sizes, grades, bevels, types of shunts and methods of connection. Brush manufacturers must make a profit to stay in business, and the user is paying for this absence of standards.

Brushes represent only part of the problem, for brushholders must also be considered. One manufacturer is producing about twenty-two hundred different brushholders. Reducing the types of brushes in use will also decrease the styles of holders. It was to relieve this situation that the Department of Commerce formed a Committee on Carbon-Brush Specifications whose work should have the whole-hearted support of all interests.

The machine builder prefers not to have restrictions placed on the design of his equipment. While much is to be said in favor of this attitude, one electrical manufacturer by a careful study of brushes used on his machines was able to reduce the number of types from two hundred and fifty to ten. Although this manufacturer produced a limited line of motors and generators, the fact that he could eliminate ninety-six per cent of the types of brushes required for his equipment shows the possibilities when a process of elimination is applied. Moreover, brushes should not be used as a means of bolstering up a poor design. If something is inherently wrong in a design it should be corrected at the fault and not by changing the grade of brushes.

The user has not always been Simon pure. He also has been guilty of trying to make up for machine defects by experimenting with different types of brushes. When a machine has been operating satisfactorily and suddenly develops commutator trouble, if the brushes are in good condition, this should be conclusive evidence that the source of the trouble is not in the brush. Instead, the fault in the machine should be located and removed.

Then and Now

FIGURES from the most recent census of manufactures, 1927, have just been released from Washington. As has been the case with such figures for the last ten years, another decrease in the number of workers engaged is shown. This time the total was 30,000 less than it was two years before. In the period from 1919 the total decrease was from 8,989,536 to 8,351,257, approximately seven per cent.

This decrease is often misinterpreted by those who assume that it means that there are just that many fewer jobs available for workers. This is, however, far from the case. Actually, there are more jobs available than ever before, the difference being that fewer are in strictly production work while a vast increase has occurred in work of a service nature.

To make this clear, think for a moment of a typical rural community of twenty years ago and what it has become today. In 1910 the country village of five hundred inhabitants numbered possibly half a dozen motor cars. These were cared for, as far as such care went, by the owners. Today, there will be a hundred cars and trucks, while, in the surrounding country, farmers by the hundreds will own cars, trucks and tractors. Telephones and electric current are now used by all, where two decades ago but a handful employed these services. And, finally, radio sets and other home electrical appliances are widespread in their use.

This has resulted in a great increase in the number of sales and service jobs in even such a small community. Men from the farms and also from the small local factories such as sawmills and gristmills (now largely gone out of existence) readily find profitable work in lines that did not exist until recently. In a great city, the proportion of new service jobs is even greater.

It is clear, therefore, that the decrease in workers reported by the census of manufactures does not mean fewer workers in the nation. So far there has been no confirmation of the oft-expressed fear that the increased use of power-driven machinery will result in restricted opportunities for employment. Instead it has greatly broadened these opportunities.

Diesel Plant of 4,600 Hp.

Supplies Long Island Town

By H. C. Major
Commissioner of Public Utilities,
Rockville Centre, N. Y.

THE building of a new 4,600-hp. Diesel-electric generating station by the village of Rockville Centre, New York, was made necessary by the rapidly increasing power requirements of this fast-growing Long Island suburban community.

As in the case of many municipal electric lighting systems, that at Rockville Center came into existence (in 1898) when the Village was quite small and the building into such territory was an unattractive proposition to private companies. Coal was cheap and the steam engine the only prime mover, so from the first, until the erection of this new station, the plant was steam driven. The equipment for many years was non-condensing steam engines and Scotch-marine boilers. In 1917 these engines were supplemented by a 500-kw. condensing turbine with the condenser water cooled in a spray pond. As long as coal was procurable at slightly over $3 per ton and the plant could be run with a small amount of labor, generating costs were not excessive, and for a small plant of this character the steam machinery was probably as satisfactory and economical as any other type of equipment. With the growing demands of the Village, it became necessary either to increase the plant capacity or to purchase current to cover the excess requirements. As the cost of coal and labor had increased to a point where the generating cost of the steam plant was 31 mills per kilowatt-hour, it was deemed inadvisable to make any additions to the plant, and, pending an investigation and thorough study of the problem, the deficiency in current was purchased from a Long Island utility. The cost of this purchased current was 3.91 cents per kilowatt-hour.

The Rockville Centre municipal plant uses off-peak power to pump water into the 500,000-gal. standpipe tank shown at the left

As will be seen from the charts on page 541, the power consumption and maximum peak loads increased from year to year, and the Village officials were confronted with the problem of deciding what was to be the future character of this plant.

In 1927, after an extensive investigation, it was finally decided to build an entirely new Diesel-engine-driven plant. It was estimated that, based on a yearly output of 5,000,000 kw.-hr., the cost of producing energy with a Diesel station would not exceed 1.86 cents per kilowatt-hour. This conclusion is based on the data as tabulated in Table I. The old plant was free and clear of any debt so that there were no outstanding bonds, and in addition there was a cash balance in the reserve fund of $80,000 which was available for the project. The Board of Trustees voted a bond issue of $380,000, which was sold to the bond house offering the low interest bid of 4.15 per cent, and construction was begun in August, 1927. After a study of the existing, and probable future load, it was decided to install three engines, two of 1,250 hp. and one of 840 hp. After considering several bids, the contract for the engines was awarded to the McIntosh & Seymour Corporation and the contract for the generators and accessory electrical equipment was given to the General Electric Company. The cost of the plant can be approximately segregated as in Table II.

The initial installation has a capacity of 2,400 kw. at the system power factor and the building and foundations will accommodate an additional 900 kw. The total ultimate cost, therefore, amounts to $172 per kilowatt.

The power-station building is 80 ft. x 100 ft. in floor plan and is 45 ft. high and is of steel-frame construction. To make the building conform architecturally with other municipal projects, and because of its prominent location, tapestry brick and artificial stone trim were used on the exterior walls. The building was made suffi-

ciently large for a total capacity of 4,590 hp. in four units, three of which make up the initial installation. It is also laid out for future extension, one wall being of a temporary character. The width of the building was made ample to permit the present crane to serve larger

TABLE I—ESTIMATED YEARLY OPERATION

Fuel oil, 5.5 cents per gallon	$27,500
Operating labor, including supervision	25,000
Lubricating oil	2,500
Supplies	2,500
Repairs and part replacement	6,000
Repair labor	7,200
Interest, at 5 per cent	22,500
Total	$93,200

units when this extension of the station should become necessary.

The units now installed consist of two 1,250-hp. four-stroke-cycle, six cylinder cross-head type engines direct connected to 1,060-kva., 164-r.p.m., 2,300-volt, alternating-current generators, and 27-kw. exciters; and one 840-hp. four-cylinder engine of the same type, direct connected to a 700-kva., 164-r.p.m., 2,300-volt generator and a 19-kw. exciter. The engine cylinders are all of the same dimensions, 23-in. bore and 32-in. stroke and practically all of the engine parts are interchangeable between these three engines.

The desirability of having all valves, rockers, pistons and piston rods and other parts identical offsets the unfavorable feature of a four-cylinder engine as compared to a six-cylinder engine, in respect to unbalanced forces. To provide against vibrational disturbances the four-cylinder engines are equipped with Lancaster type dampeners.

All the exciters are over-sized, as it is planned to supply field current to two generators from a single exciter and a motor-driven exciter set in case of an exciter failure.

Air for both the working cylinders and the air compressors comes through flues built in the walls of the building into a 20-in. pipe header that runs along one wall as shown in the photograph of the engines on page 539, from which it is led to the air manifold *(A)* on each engine. The air for the compressors passes through filters placed between the header and the compressor connections.

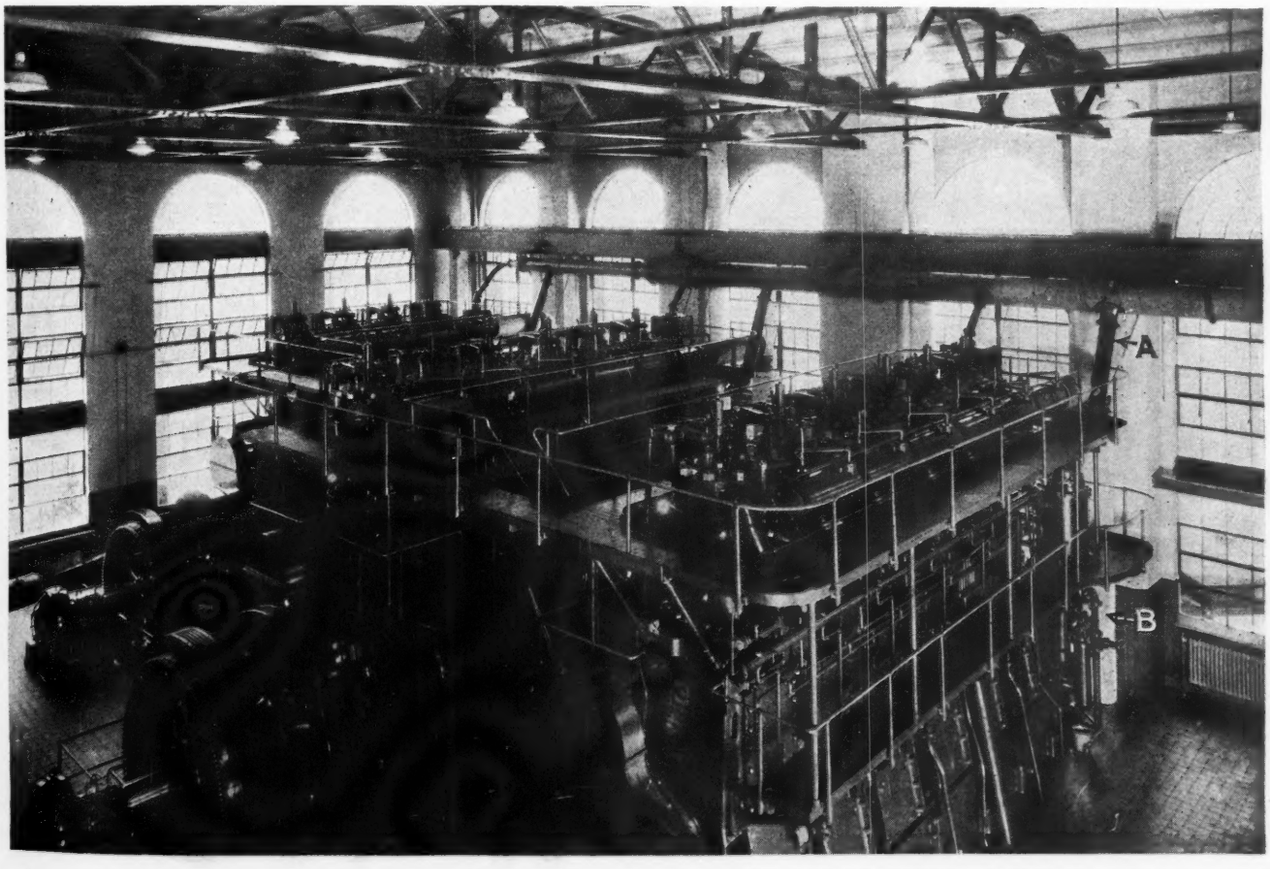
The exhaust gases pass from the cylinders into a water-cooled manifold, and thence through an insulated pipe *B* vertically to the basement. Here the gases flow through a three-way valve to either the exhaust silencer and vertical discharge pipe or to the exhaust-gas steam-heating boilers. These waste-heat boilers are designed to absorb sufficient heat from the exhaust gases to supply

TABLE II—SEGREGATION OF PLANT COST

Diesel engines, including generators, exciters and erection	$258,000
Switchboard, wiring and accessory electrical equipment	21,000
Building and foundation, including waste-heat boilers and heating plant	159,000
Auxiliary equipment and piping	18,000
Total	$456,000

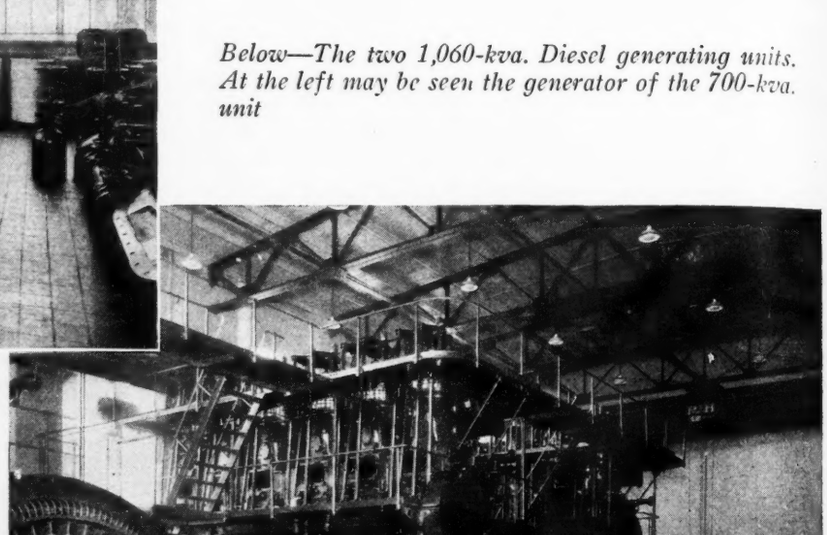
the heating requirements of the building. The boilers were built for 15 lb. working pressure, but during the past winter it has not been necessary to carry it above 0.5 lb., regulation being obtained by manipulation of the three-way valves. The steam is also used to clean lubricating oil and for hot-water supply.

The fuel oil facilities include two 20,000-gal. steel,

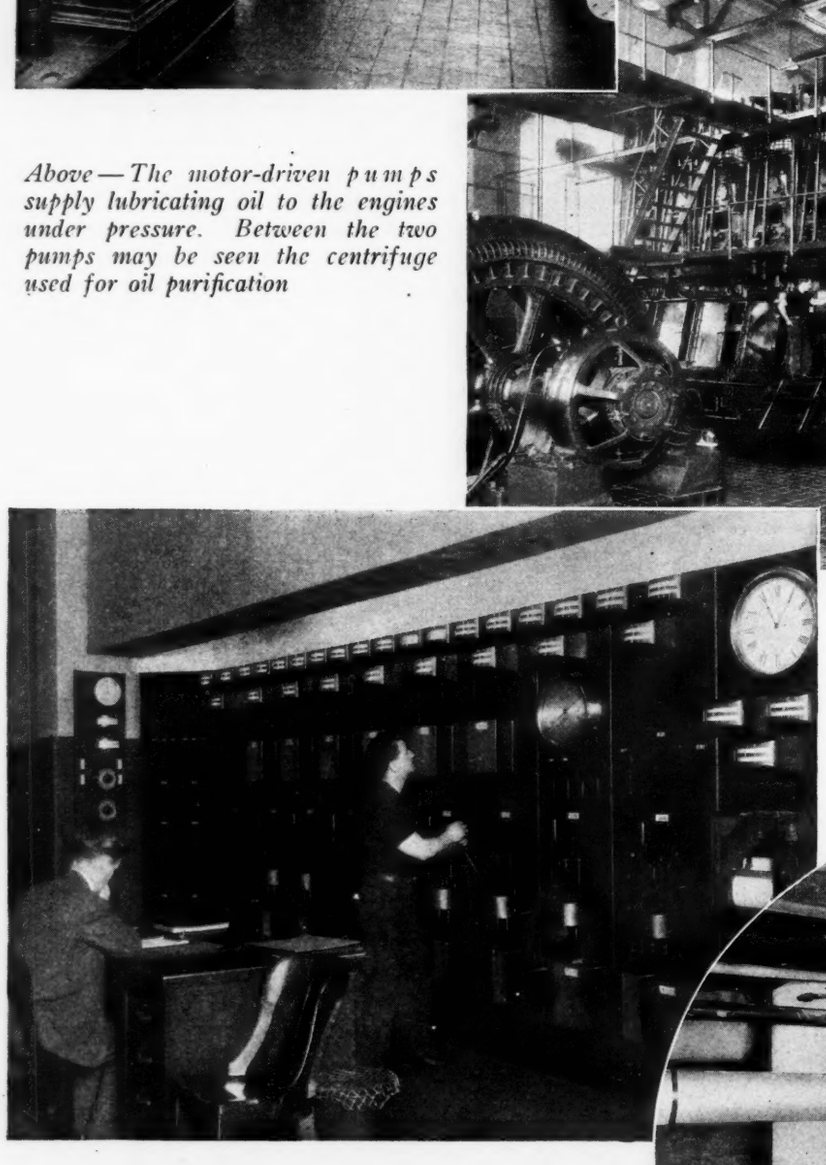


In the foreground are the two 1,060-kva. Diesel units and behind them the 700-kva. Diesel unit. Pipe A supplies air to engine while B conducts the exhaust gases to waste-heat boilers in the basement

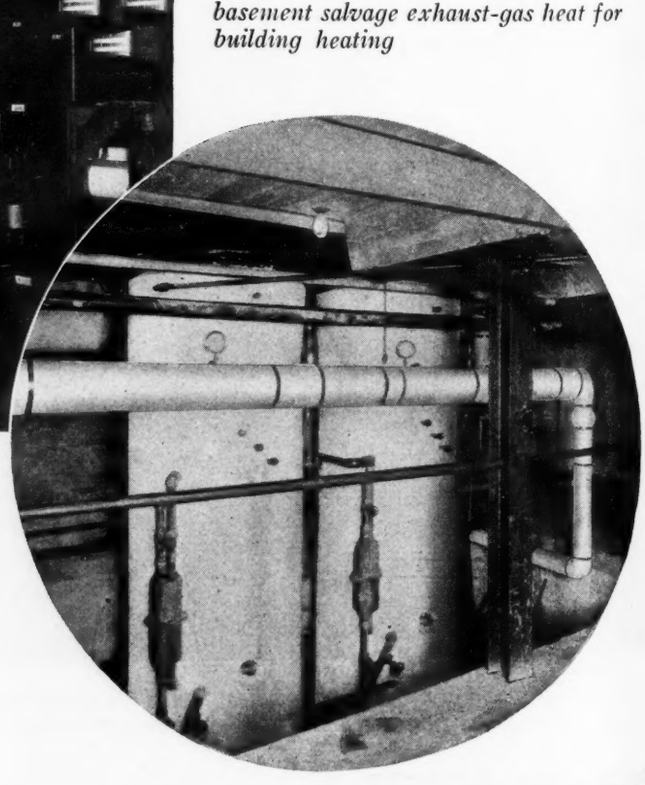
Below—The two 1,060-kva. Diesel generating units. At the left may be seen the generator of the 700-kva. unit



Above — The motor-driven pumps supply lubricating oil to the engines under pressure. Between the two pumps may be seen the centrifuge used for oil purification



Below — Waste-heat boilers in the basement salvage exhaust-gas heat for building heating



Above — The eighteen-panel switchboard is completely furnished with instruments

above-ground, storage tanks into which the oil is unloaded, by a motor-driven rotary pump direct from tank cars on the station siding. These tanks have not been equipped with heating coils as the 22-deg. Baumé gravity oil that is now in use is sufficiently fluid in the prevailing winter weather to be free flowing. From the storage tanks the oil is forced by rotary pumps to two 500-gal. running tanks situated on the balcony above the machine shop. From these tanks the oil flows to the engine fuel pumps by gravity. It has not been necessary to filter the oil, but it is passed through twin strainers both before delivery to the storage tanks and before entering the engine fuel pumps.

In addition to the fuel-oil tanks, a kerosene tank and pipe lines are provided, as this is part of the equipment of this particular engine builder, to permit operating the engines on kerosene for a few minutes when stopping and starting. However, the fuel now used is of such high quality that this practice has not been necessary.

The lubricating oil system was designed with a view to reducing the oil consumption as much as possible, to insure a clean and constant supply of oil at all times and to guard against any failure. The lubricating system of each engine is a complete unit capable of being operated independently, and the whole system is so interconnected that the separate units may be used with different engines.

All engine bearings are force-feed lubricated at 10-lb. pressure. The oil flows from the crank case into the 750-gal. sump tanks located in the basement. These tanks have two compartments, the oil being delivered to the first compartment for settlement of foreign matter, and then flowing over a screen-covered weir partition into the second compartment. A motor-driven rotary pump picks up the oil from the sump tanks and forces it back into the oil header to the engine bearings. Each engine is provided with a twin strainer and cooler through which the oil passes before entering the engine system. The pumping is so arranged that any one of the three sump tanks can supply any of the three engines, and one of the pumps has sufficient capacity to supply two engines.

Periodically, about once in thirty days, the oil in one of the engine systems is cleaned. The oil is pumped into a tank in the basement provided with steam coils. Here it is heated to 180 deg. F., after which it is pumped by a rotary pump to the Sharples centrifugal having a capacity of 150 gal. per hour. The foreign matter is removed and the oil is discharged into a 750-gal. oil-transfer tank in the basement. After the sump tank is cleaned, the oil is returned from the transfer tank.

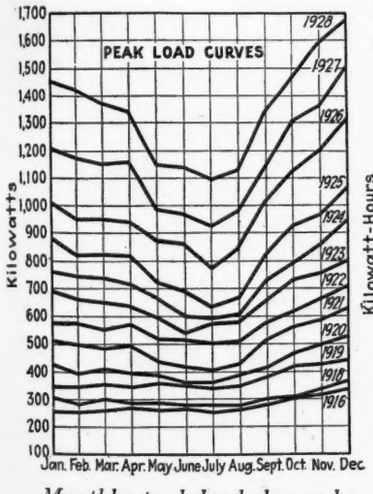
Cooling water is taken from the Village water system and wastes to the sewer. There are, however, on the property, wells belonging to the old water system that have been equipped with pumps to act as an auxiliary water supply. It is not believed that recooling of the water is justified as the cost of the water taken from our own system is very low. However, this assumption may be modified after we have been able to compile actual operating costs.

The switchboard is made up of 18 panels, consisting of: 1 exciter panel, 6 generator panels, 3 of which are not wired or equipped, 1 totalizing-meter panel, 1 station-service panel, 1 water-plant panel, 6 commercial-feeder panels, 2 street-lighting panels. There are also two small instrument panels, one at each end of the switchboard.

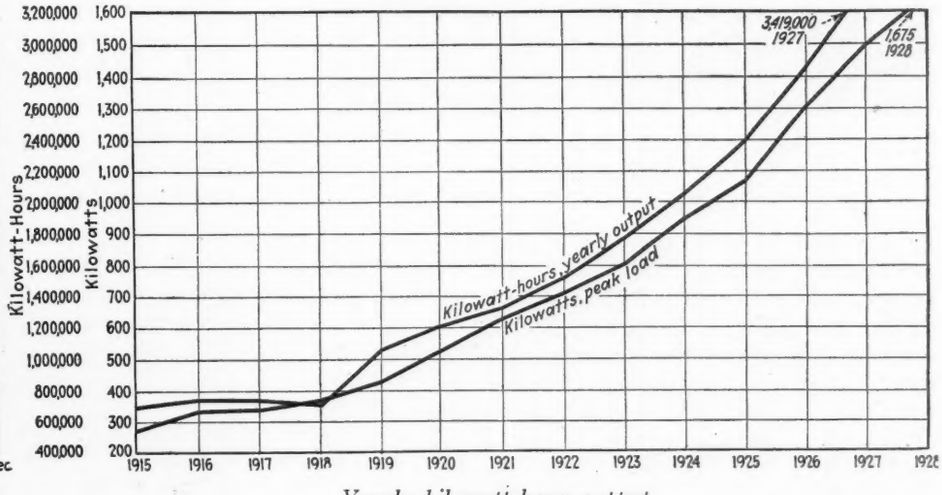
As will be seen from the photograph of the switchboard, it is placed in a recess for the purpose of giving the instruments ample protection from possible mechanical injury. Behind the switchboard is located the pipe rack, carrying busbars, oil switches and all high-voltage wiring. Above this switchboard there is an additional electrical gallery that has been provided for the motor-driven generation rheostats, the street lighting equipment, static condenser, etc.

Attention is called to the pyrometer, that is mounted on one of the small instrument panels. This instrument is provided with two dial switches having a total of 24 contact points, of which 16 are now connected with thermo-couples, one located in each of the 16 exhaust nozzles of the engines. In operation, the pyrometer has been of considerable advantage in the balancing of engine cylinders and in forecasting engine troubles. It has been possible to maintain the temperature of the several exhausts of an engine within a 10 to 20 deg. F. range.

The plant maintenance is taken care of by the installation of a machine shop, which will contain a 20-in. swing lathe to handle valves and bearings, drill press, grinders and other portable tools. A 15-ton, 63-ft.-span box-girder hand-operated crane, equipped with a 3-ton aux-



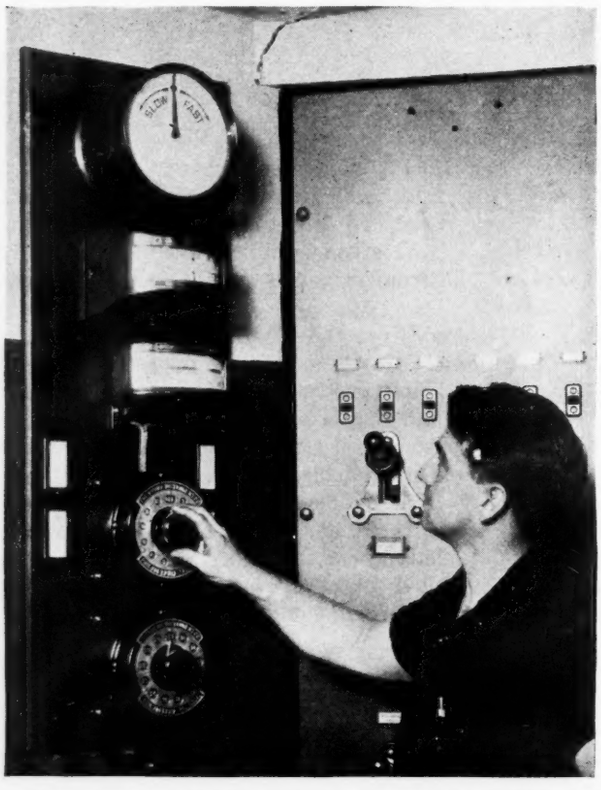
Monthly peak-load demand



Yearly kilowatt-hour output

iliary carriage and hoist, enables any engine part to be handled and moved with ease and dispatch.

It is the expectation that within a reasonable period the plant will pay for itself out of the decreased generating cost. There is every reason to believe that the generating cost will fall below 1.6 cents per kilowatt-hour. Based on 5,000,000 kw.-hr. annual output, the reduction of 1.5 cents per kilowatt-hour will mean a saving of $75,000 yearly. In other words, the plant will



The engine cylinders are balanced with exhaust pyrometers

pay for itself in six years through the saving effected over the production cost of the old plant. Part of this saving will be accomplished through the consolidation of the electric lighting and water systems.

In the design and construction of this station, the writer has received the fullest co-operation and assistance from the Board of Trustees and particularly from Mr. R. C. Daisley, chairman of the Public Utilities Committee, and, also from Mr. Cyril E. Marshall, consulting engineer, who is responsible for the design.

PRINCIPAL EQUIPMENT

Engines	Three two-stroke-cycle Diesel, 164 r.p.m.
Capacity	Two 1,250-hp.; one 840-hp.
Cylinder sizes	23x32 in.
Make	McIntosh & Seymour Corp.
Generators	Two 1,060-kva. and one 700-kva. General Electric 2,300-volt alternators
Exciters	Two 27-kw. and one 19-kw., General Electric Co.
Exhaust-gas boilers	Davis Engineering Corporation
Air filters	Midwest Air Filter Co.
Air ducts	American Spiral Pipe Works
Silencers	Maxim Silencer Co.
Oil centrifugal	Sharples Specialty Co.
Fuel oil pump	A 2-in. Blackmere geared to 2-hp. G. E. motor One 3-in. geared to 3-hp. motor One 1-in. geared to ½-hp. motor
Lubricating-oil pump	Three 2-in. Viking rotary geared to 3-hp. G. E. motor; two 1 in. to ½-hp. motor
Oil coolers	Schutte and Koerting Co.
Switchboard	General Electric Co.
Crane	15-ton Harnischfeger Corp.
Valves	Lunkenheimer Co.

Lighting Motor-Generator Sets Controlled Automatically

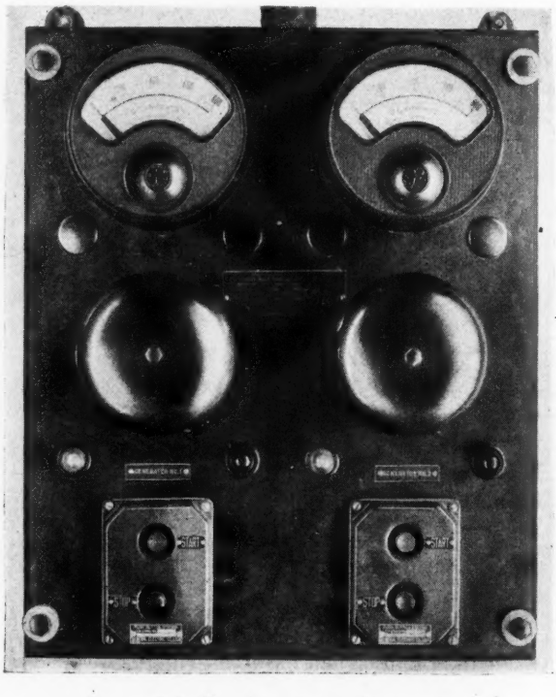
By A. E. Beardmore
Industrial Engineering Department, General Electric Company

THE municipal auditorium at Minneapolis, Minn., has an unusual arrangement of flood-lighting equipment. The floodlights are located at several points remote from the motion-picture equipment and from each other; the operators, therefore, have no way of knowing what the combined load is.

To meet this situation special control panels were designed. Two motor-generator sets, two automatic starters, two automatic generator-control panels, a distribution panel and a control-station panel make up the equipment.

Each generator panel is provided with a relay arranged to start the second motor-generator set when the load on the first exceeds a fixed value. This relay also shuts down the second set when the load falls to such a value that the first set can carry it. With this arrangement only one set is used unless the load is actually in excess of the capacity of one set. The control is so arranged that either motor-generator set can be started first in order to equalize the wear on equipment, and considerable overlap is provided in the setting of the automatic start and stop relays to prevent hunting.

Provision is made so that when a set is started automatically by the relay, the field rheostat is short-circuited



Control-indicating and alarm panels

temporarily to make the generator build up voltage quickly. A relay also controls the direct-current line contactor so the second generator cannot be connected to the bus unless the voltage is built up to the proper value. If a generator fails to build up when a set is started, the relay prevents the contactor from closing. This prevents the heavy flow of current that would otherwise occur and that would create sufficient disturbance to spoil a motion picture. An alarm bell will also ring, warning the operator that the second set has failed.

Chart for Determining Loss Due to Moisture in Flue Gas

By C. A. KULMANN
Pelton Water Wheel Co.

THIS nomograph gives a short, accurate means of finding the loss in boiler plants due to evaporating and superheating the moisture in the waste gas resulting from moisture in the original fuel and moisture due to combustion of the hydrogen in the fuel. The formulas involved are:

$L_1 = MH_w \quad L_2 = 0.008HH_w \quad H_w = 1{,}089 + 0.46t_s - t_a$

where L_1 is the loss due to the moisture in the fuel in B.t.u. per pound of dry fuel, L_2 is the loss in B.t.u. due to the hydrogen in the fuel, M is the amount of moisture in the fuel per pound, H is the weight of hydrogen per pound, H_w is the heat loss per pound of water in the flue gas, t_s is the temperature of the flue gas, and t_a is the initial temperature of the fuel.

To use the chart, find in the central graph portion the intersection of the vertical line of gas temperature with the line of initial temperature, and proceed horizontally across to the right to the intercept on the heavy line *C-C*. Using a straight-edge, connect this point to the per cent moisture and read the heat loss per pound from scale L_1. From this point connect to the heating value per pound of fuel and read the per cent loss as one-tenth the scale values on the side corresponding to the side of the calorific scale used.

To find the loss by hydrogen, start with the same point on line *C-C*, and connect with the proper value of per cent hydrogen reading the heat loss per pound from scale L_2. Proceed as before to find per cent loss, but read the actual scale values.

An example will serve to illustrate how the chart is used. Assume a coal of 14,000 B.t.u. containing 4 per cent moisture and 5 per cent of hydrogen has been burned under a boiler that reduced the gas temperature to 500 deg. The initial temperature of coal will be taken as 80 degrees.

Enter the graph portion of the chart at 500 deg. and proceed vertically to the curve marked 80 deg. Transfer the point of intersection horizontally to the line marked *C-C*. Lay a straight-edge on this point and 4 per cent on the moisture scale. On scale L_1 read the heat loss of 49 B.t.u. due to moisture. To find the per cent loss, connect with the straight-edge the heat loss just found and 14,000 B.t.u. and on scale *A* of the per cent scale read the per cent heat loss as one-tenth the scale value, or 0.35 per cent.

For the heat loss due to hydrogen connect the reference point on *C-C* with 5 per cent on the scale marked per cent hydrogen, and on scale L_2 read the heat loss of 555 B.t.u. The per cent loss is found in the same way as indicated for per cent loss due to moisture except that the scale values are used directly.

The total heat loss due to moisture is the sum of the two components giving a total loss of 604 B.t.u. or 4.3 per cent.

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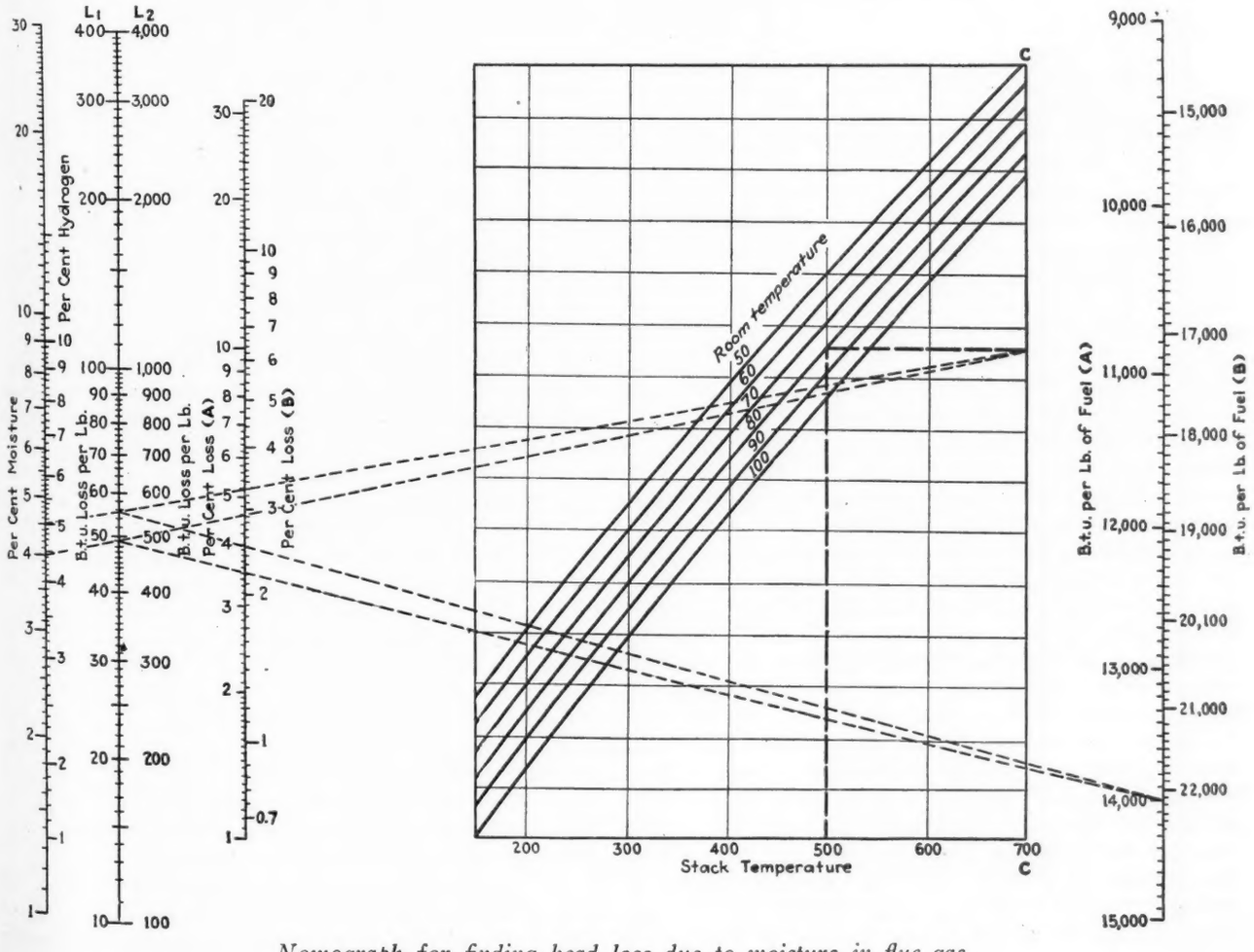
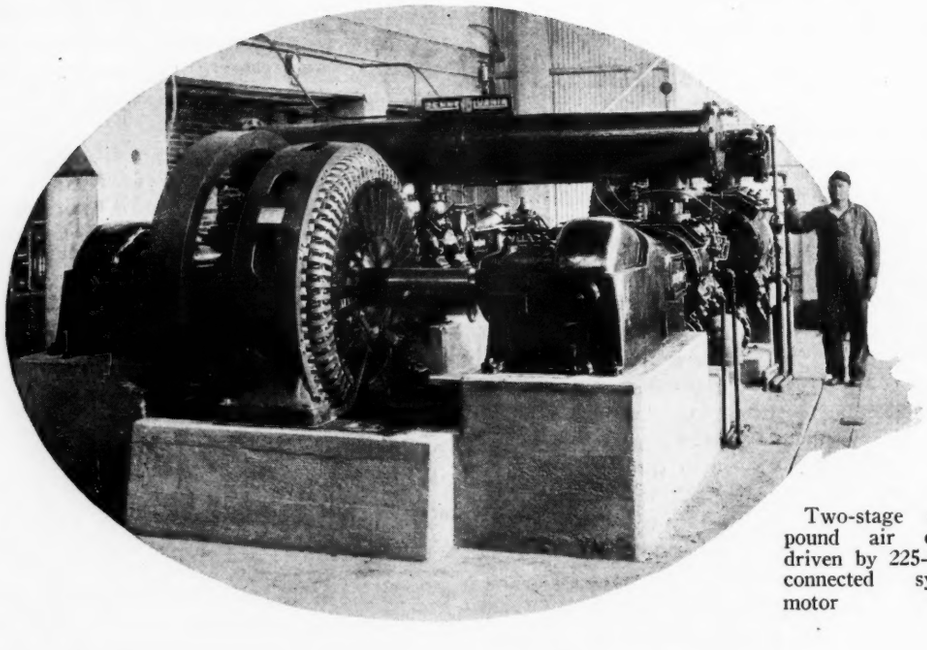


Nomograph for finding head loss due to moisture in flue gas



Two-stage cross-compound air compressor driven by 225-hp. direct-connected synchronous motor

MOTOR DRIVES *for Air Compressors*

By Ward Raymond

President
Pennsylvania Pump & Compressor Company

These include slow-speed synchronous types with rotors mounted directly on the crankshafts and high-speed induction types connected to the flywheel by some form of speed reducer.

THE use of electric motors for driving air compressors of all types is practically universal, but the methods of drive are almost as many as there are different types of motors, since each type of motor construction has features that make it especially applicable to the conditions met with in certain compressor installations.

Generally speaking, the drives may be divided into two classes: Belt driven, where the motor and compressor are connected by belting of some type; and direct connected, where the rotating element of the motor is directly attached to the compressor, usually by having its rotor mounted on the compressor shaft.

As a rule, the belt-drive arrangement is used chiefly for the smaller installations where a general-purpose motor of medium speed is suitable. The direct-connected mountings are more likely to be used on larger installations where a synchronous motor is desirable, owing to the inherent low power factor of slow-speed induction motors.

For the belt-drive installation the usual practice is to employ what is called the short-center drive. This method consists in placing the motor close to the compressor and running an idler pulley on top of the belt to take up the slack and maintain the required tension. Examples of such drives are those known as the Lenix and the Pulmax. A compressor driven by a motor through a short-center belt is shown in the Fig. 1. A floating arm carries the idler pulley and is hinged to the compressor frame so that it may rise and fall, at the same time maintaining its alignment between the motor and compressor pulleys.

The idler pulley should have sufficient weight to maintain proper tension on the slack side of the belt and should also be of a diameter proportioned to the type and flexibility of the belt. If the pulley is too light in weight, there will not be sufficient friction between the belt and the motor pulley to prevent slipping, particularly when starting. Among the many advantages of this type of drive is that placing the motor close to the compressor saves considerable space compared with a long belt drive. It is difficult to obtain with a long-belt drive an arc of contact on a motor pulley of 180 deg., whereas, with a short-belt drive an arc of contact with the motor pulley as high as 250 deg. is possible with the arrangement shown. Wrapping the belt around the motor pulley greatly increases the load capacity.

An important feature of the short-belt drive is the way it automatically takes up any stretch in the belt nd adjusts the tension to the load. When the compressor

is running idle or unloaded, the belt has little load on it and is in a relaxed condition. As the load comes on, the tension on the tight side of the belt increases, causing a slight stretching. This stretch is automatically taken up by the idler pulley, so that a working tension is maintained. Belts for this service should be made endless to pass smoothly over the idler pulley and they should be of a particularly flexible grade in order to hang closely to the motor and the idler pulleys. Even when a flexible type of belt is used, there will sometimes be a slight slipping when the belt is first run, but this will work out and may be helped by a light application of suitable belt dressing.

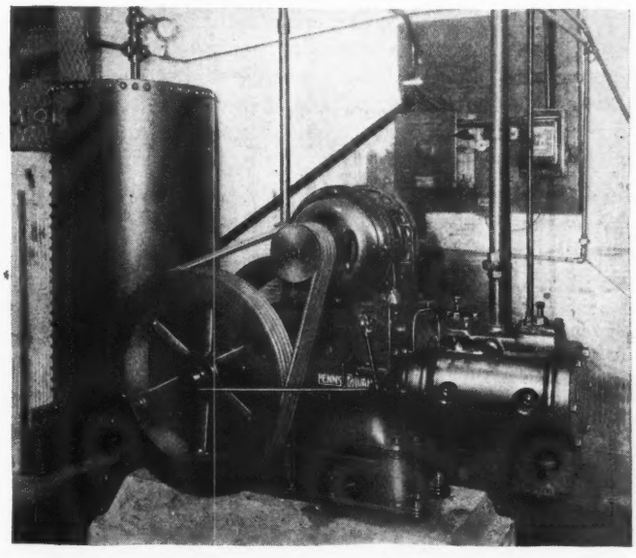
Another type of belt drive that is coming into favor is an adaptation of the multiple rope drive, using a number of V-shaped fabricated belts. This type is exemplified by the Texrope and the Cog-belt drives. The sheaves are provided with a number of V-shaped grooves in which run V-shaped belts of fabric and rubber. As these belts wedge into the grooves, their coefficient of friction is high and consequently the motor and compressor sheaves may be run on close centers without the use of an idler pulley. Fig. 2 shows a special application of one of these drives and indicates their ability to operate on short centers without the use of idlers. In this application the motor is mounted on a special base placed on top of the compressor frame, and the belts lead direct from the motor pulley to the compressor drive wheel. This method of mounting across the solid top of the compressor frame provides a firm support for the motor and saves the floor space the motor would otherwise have to occupy.

Since an idler is not customarily used to take up the slack on the V-belt drive, any looseness due to stretch or wear of the belts is taken up by adjusting the position of the motor. As the belts are of fabricated-rubber construction, they are not susceptible to moisture, and this type of drive is therefore particularly suitable for installations where damp conditions exist. These belts are also suitable for use in dusty or dirty air. Owing to the wedging action of the belts in the grooves there is no slippage, and grit or dust does not have a cutting action on the surface of the belt.

The use of gearing to connect motors to compressors is limited to special applications where substantially direct connection is required. In such cases a quiet, slow-speed motor is used and it is customary to inclose the gears and run them in an oil bath.

Compressors of larger sizes, requiring motors of approximately 100 hp. and over, are usually driven by slow-speed synchronous motors mounted in line with the crankshaft. Mounting these motors on the shaft gives the simplest arrangement of drive. The compressor bearing also serves for the motor and there are no driving belts or gearings. No additional floor space is required except for a slight widening of the frames necessary to accommodate the motor. The amount it will be necessary to increase the frame's width depends somewhat upon the design of the motor. As a matter of fact, a large saving of floor space is effected by the synchronnous motor drive over any other method of driving compressors except the overhead mounting with multiple-belt drive, Fig. 2.

When the motor is to be mounted on the compressor shaft, if the rotor is of the split type the compressor and motor may be shipped separately and readily assembled when installed. If the rotor is not split, it is necessary for it to be pressed on the shaft before one of the crank disks is placed in position. In such cases it is customary to forward the compressor shaft to the plant of the motor



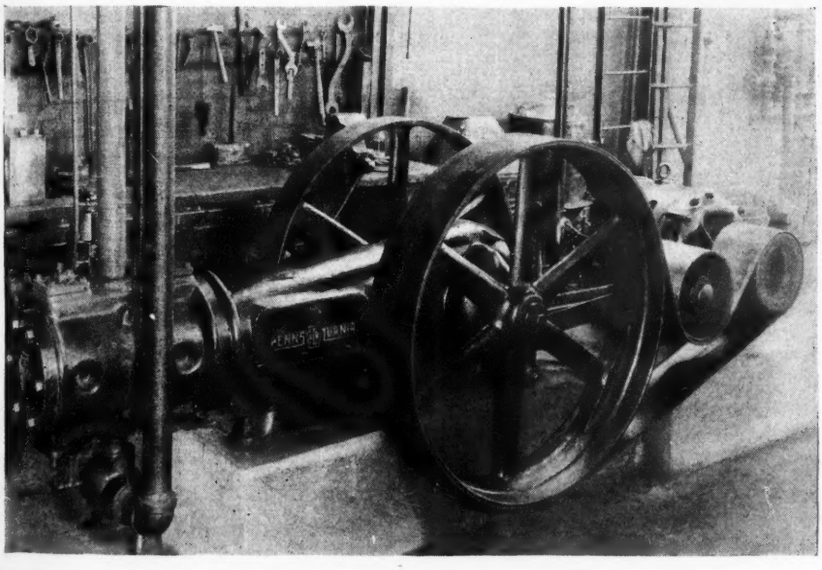


Fig. 1 (Left)—An 8x8-in. air compressor driven through a short-center belt by a 20-hp. high-speed induction motor

The compressor speed is 325 and the motor speed is 1,155 r.p.m. This arrangement allows placing the motor close to the compressor. The idler pulley is hinged to the compressor frame by a floating arm, which allows free motion of the pulley on the belt.

Fig. 2 (Top)—High-speed induction motor mounted on top of the compressor and connected to the flywheel by V-shaped fabricated belts running in grooves in the motor pulley and the compressor flywheel

This makes a compact drive and the whole unit sits in the space occupied by the compressor.

manufacturer, whence, after the rotor has been pressed on, shipment is made direct to the customer. This practice precludes using the motor when the compressor is tested at the factory. An exception to the practice of having the motor manufacturer press on the rotor would be where the customer has facilities to do this work in his own plant.

Advantages of Synchronous Motors

The many advantages of the synchronous motor are well known, and this type is particularly well adapted to compressor drive. The compressor can be unloaded during the starting period so that the torque requirements are well within the starting and pull-in torque of slow-speed synchronous motors. The motor driving the compressor can be a leading power-factor machine and thus secure the beneficial effects of this type of motor in raising the power factor of the electrical system. This is a

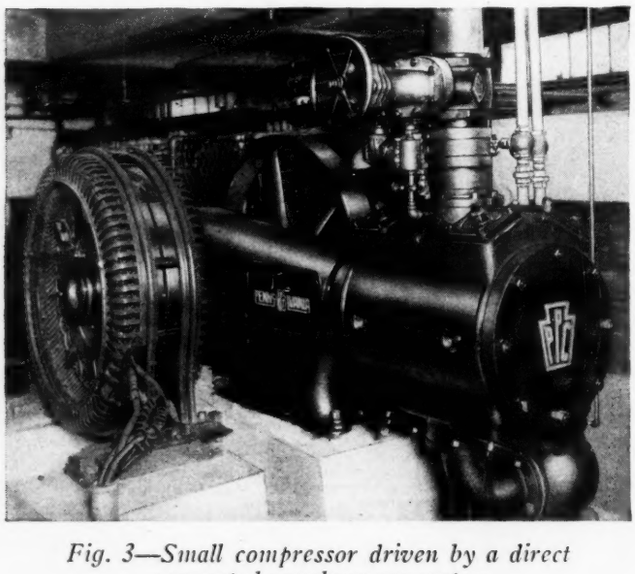


Fig. 3—Small compressor driven by a direct connected synchronous motor

The rotor is mounted on one end of the crankshaft, which allows placing the stator close to the compressor frame, in the place usually occupied by the belt pulley.

feature that is of increasing importance, as power companies are now incorporating in their contracts a power-factor clause that gives lower power rates for loads having a high power factor. Where slow-speed synchronous motors are used for driving compressors, they are usually started on full voltage, which simplifies the starting equipment required.

Another advantage of direct-connected synchronous-motor drive is that the motor delivers its power directly to the shaft of the compressor, with a consequent reduction of the power losses which result from the use of speed-reducing devices.

When comparing the efficiencies of direct-connected, low-speed synchronous motors with high-speed induction motors, it should be borne in mind that the generally higher efficiency of the high-speed induction motor is offset by the losses of the speed-reducing devices, which should be charged against the induction motor. As an illustration assume that the losses of speed-reducing devices amount to 7½ per cent. With an induction-motor efficiency of 90 per cent at full load, this would result in an over-all efficiency for the induction-motor drive of 83.25 per cent. The efficiency at full load on the synchronous motor, including excitation losses, will be, say, 89 per cent, or a gain of 5.75 per cent.

This comparison further favors the direct drive when the power factor is considered. With a synchronous motor the kilovolt-ampere input is lower than on the induction motor, and the power factor of the induction motor is always below unity. The power factor of the synchronous motor, with excitation fixed for unity at full load, becomes leading as the load decreases.

A special application of the synchronous motor to smaller compressors of the straight-line type is shown in Fig. 3. This compressor drive, which was developed by the Pennsylvania Pump & Compressor Company, consists of mounting the motor's rotor upon one end of the crankshaft. This allows the stator to stand close to the compressor frame in the place usually occupied by the belt wheel. The figure is a typical installation and shows the compact arrangement. The mechanical efficiency of such a drive is high as the motor exerts a turning force only on the shaft and relieves the main bearing of the constant load imposed by a belt pull.

While there is considerable flywheel effect in the rotor, such additional as may be needed is readily provided in the flywheel on the opposite end of the shaft. Though this drive is of comparatively recent development, it has won wide favor where the elimination of belt or the advantages gained by the use of a synchronous motor are found to be desirable. The practice of employing a taper fit for mounting the wheels on the crankshaft is particularly advantageous for direct mounting of the motor on the shaft, as the compressor and motor may be shipped separately and mounted on the shaft without trouble by the customer.

Proper Location of a Belt Tightening Pulley

There have been many mistakes made in locating the tightening or idler pulley on short-center belt drives. These pulleys should be made to perform two functions; namely, take up the slack of the belt and wrap this slack around the small pulley. By doing this the belt can operate with a minimum of tension for a given power load. This is desirable as it keeps the power losses and the wear on the bearings at a minimum, and the bearings are easier to lubricate. Low tension in a belt is favorable to long life and satisfactory operation, other conditions being equal.

To obtain the best result with the idler pulley, it should be located close to the small pulley. The idler should be fulcrumed so that in taking the slack out of the belt it will tend to rotate about the small pulley, which requires that the fulcrum be placed outside of this pulley. Where the fulcrum must be placed near the large pulley, the idler frame should be made long enough to bring the idler near the small pulley. It is also advisable to have considerable slack in the belt. Two or three inches clearance between the two inner surfaces of the belt are sufficient for safe operation. Within safe limits, the more slack in the belt the better, as it allows more wrap around the small pulley and a lower tension in the belt without slipping. Reducing the amount of slack in a belt increases its tension for a given weight of idler. This is a point frequently overlooked and has been the cause of unsatisfactory operation of short-center belt drives.

Selecting a Coal and Ash Handling System

FOR THE SMALL PLANT

By W. G. Plehn
Efficiency Engineer
Northwestern Public Service Company

THE economical handling of coal and ashes in the smaller steam power plant sometimes presents a problem that merits considerable study. Oftentimes the labor involved in handling the coal and ash, more or less by manual labor, seriously affects the production costs yet the volume of material handled will not warrant the necessary expenditure for the complete and elaborate equipment designed for larger stations.

It then becomes an economic problem as to just what investment the present labor costs with the anticipated growth of the plant will justify, and what available machinery for this expenditure is best suited for the operating conditions.

In the plant, herein described, it became necessary to increase considerably the station capacity. The plan included the expansion of the station from its original generating capacity of 800 kw. to 2,300 kw. with a later ultimate station capacity of 8,500 kw. Little additional space was available, and the old equipment had to be replaced piece-meal as it was necessary to maintain service while the work was being done. During a two-year period, four hand-fired boilers were replaced by three large modern units, and several obsolete steam and oil engines were replaced by a 2,500-kw. turbine.

In laying out plans for the coal and ash handling equipment, the choice of systems depended largely on such limiting features as initial cost, space available, capacity necessary, labor necessary and operating cost. These factors necessarily entailed some compromises, and the plan finally evolved as best meeting the requirements is shown in the accompanying illustrations.

The coal bunker had to be located to permit tube replacements in the boilers, which meant it had to be clear above the boilers, or if placed low down, arranged to permit tube withdrawals. As the higher position would increase the building height, the lower location was chosen. In the vertical partition separating the bunker compartment from the boiler room proper, are removable panels that can be taken out, if necessary to pull tubes from the boiler. Coal is handled entirely with an electric clam-shell bucket operated on overhead monorail. The monorail extends over the unloading track and over sufficient yard storage space to store about 1,500 tons. Coal is received in open, flat bottom cars, and the handling arrangement is quite flexible. It can be unloaded from the cars directly to the bunkers or placed in storage. In fact, the coal can be shifted anywhere within the limits of the monorail. Provision is made for future extension of the overhead system to increase storage facilities.

The only two appreciable items of maintenance, and these have been quite low, are trolley shoes and cable replacement for the clam shell. The average time required for unloading a 50-ton car is about three hours. A helper is required to assist in placing and guiding the clam-shell bucket when unloading from cars and there is some little final cleaning of the car by hand necessary after all possible has been removed with the bucket. At present about 1,500 tons of coal a month are burned. A monorail operator and helper working eight hours a day, unload and handle all the coal, keep the storage pile trimmed, load all ashes from the storage pit to railway cars and maintain the equipment.

There is a monorail track scale inside of the entrance of the building and every bucket of coal brought to the bunkers is weighed and recorded. The bunkers are divided into compartments, one for each boiler so that a record of the coal burned under each boiler is readily obtained.

The first two boilers installed were equipped to burn pulverized coal with a unit pulverizer for each boiler. Coal is fed through a spout in the bottom of the bunker to a small hopper on a short conveying belt. There is an adjustable gate and also a variable speed device on the motor-driven belt to regulate the coal fed to the mill.

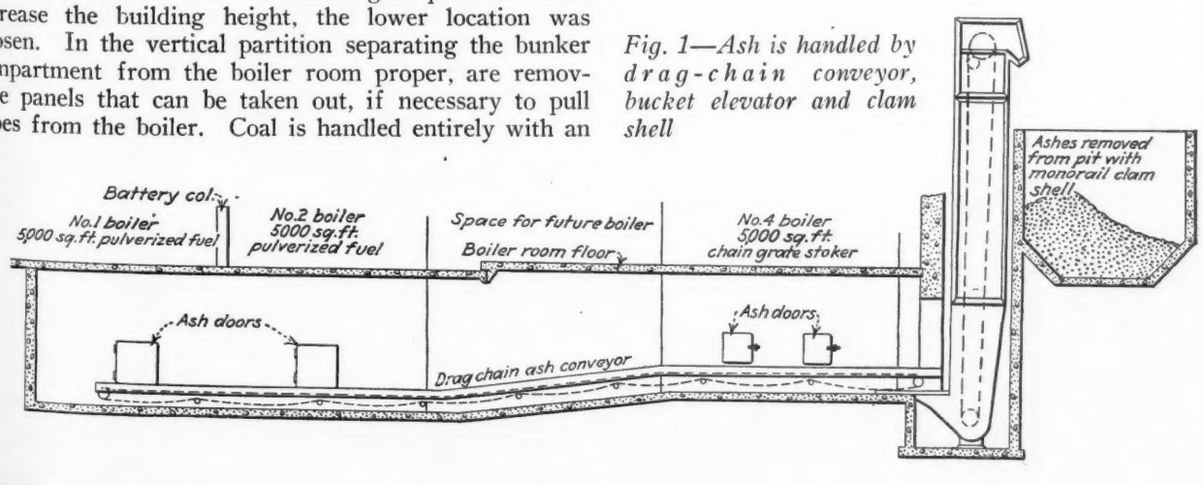


Fig. 1—Ash is handled by drag-chain conveyor, bucket elevator and clam shell

A counter on the short endless conveying belt registers the number of revolutions, and a multiplier is determined for each definite gate opening. This serves as a fairly accurate coal meter, and a continuous record can be kept of the performance of each boiler.

The No. 4 boiler, which was the last installed, is equipped with a traveling-grate stoker. The coal bunker was too low to permit the coal to be fed into the stoker hopper by gravity so a short screw conveyor was provided for this purpose. The small motor driving this conveyor also drives a scroll placed in the hopper which distributes the coal evenly in the hopper. This apparatus also provides a practical method for tempering the coal, if desired. A water connection is made into the screw conveyor close to where the coal enters from the bunker.

The partition between the coal bunkers and boiler room is dust proof; the feed device and pulverizing mills are totally enclosed and the coal fed to the stoker-fired boiler is dampened.

The ash handling equipment, shown in Fig. 1, was first installed only for the stoker-fired boiler No. 4. When

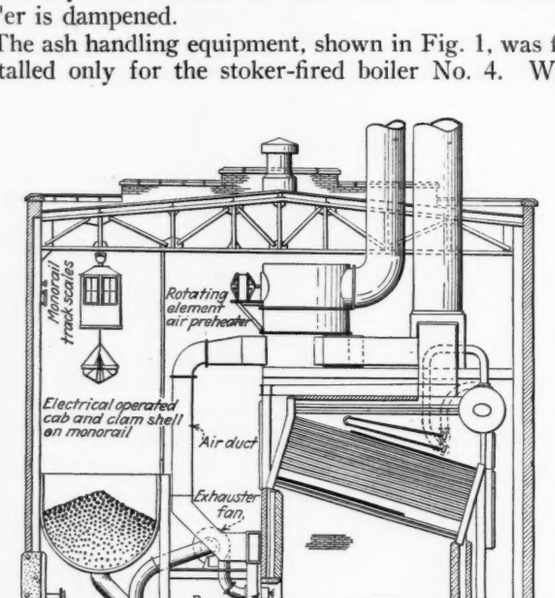


Fig. 2—Coal is handled from car or storage to bunker by monorail clam shell

the two boilers burning pulverized fuel were first installed, no ashpits or ash handling equipment were provided. This was in the nature of an experiment and with the kind of fuel available, considerable trouble was experienced with ash and slag in the furnaces. The boilers could not be operated continuously for more than a week without shutting down and laboriously removing the ash and slag by hand. The furnaces for these boilers were later remodeled. The furnace volumes were increased, ashpits provided and the drag-chain ash conveyor was extended from No. 4 boiler to serve these two boilers. The loose ashes are now removed every eight hours while the boiler is in service. The monorail clam shell is used to load the ashes from the outside storage pit to railway cars.

The equipment as a whole has so far rendered satisfactory service and has met the conditions as originally planned.

How Heat Penetrates Refractories

KNOWLEDGE of just how refractories perform is not as widespread as might be. This makes particular interest attach to a technical bulletin recently issued by the American Refractories Institute. In this pamphlet M. C. Booze discusses the way in which heat penetrates refractories and the consequent effects.

Certain common ideas concerning refractories would be dispelled by wider knowledge of the facts. For instance, it is often thought that a thin coat of refractory cement will prevent rapid destruction of furnace linings by lessening the heat penetration. The laws of heat flow show that this is not generally true, and, where found, the effect is soon obscured.

Another idea is that cooling the outer face of the refractory wall with air or water reduces the temperature of the hot face considerably. This is so with some conditions of heating and with thin walls. Generally, however, it is not noticeably effective in lowering the temperature at the face.

Many believe that the porous, hand-made firebrick are better heat insulators than the denser products of other manufacturing methods. Voids and pores lower heat conductivity, but this result is dependent upon pore size, continuity, number of pores and other factors, so that no general statements can be safely made. Studies carried out in the laboratory on such brick show that variations in performance of commercial fireclay brick due to differences in porosity are almost negligible.

In most furnaces heat is carried to the walls by radiation and by conduction from the gases or air present in the furnace. With other factors constant the heat radiated from the gases varies as the fourth power of the temperature, so that radiation in high-temperature furnaces is the important factor in transferring heat to the walls. At the hot face of the wall there is a surface or skin effect that offers some resistance to the flow of heat inward, by an amount determined by the nature of the surface material and its properties.

After penetrating this skin, the heat passes into the wall, raising the temperature of the refractory material. When this becomes saturated, the heat passes on and is absorbed either by the cooling medium or by material in contact with the outer face. When this face is bare and exposed to the air, there is a decided temperature drop or gradient, ranging from the furnace temperature to a temperature but slightly higher than that of the room. When insulation is used, this range is less.

Vitrification of the refractory due to the heat occurs only at the hot face, except where joints or open cracks allow the heat to penetrate.

It is theoretically possible to produce a surface on a refractory wall that will resist the passage of heat, thus producing a lower mean wall temperature. This resistance will depend, however, upon the surface characteristics. When this surface becomes coated with ash or slag or altered from vitrification, it will show little or none of this resistance.

Cooling by air or water has little effect in reducing the temperature at the hot face of a refractory wall, because the loss of heat due to the cooling is almost entirely made up by additional heat radiated from the hot gases. Where walls are thin, the heat flow through the refractory to the cooling medium is more rapid than that from gases to wall, and the temperature is somewhat lowered. But this is not so with thick walls, so that cooling them in this manner does not reduce slag action.

Keeping Down the Maximum Power Demand in the Ice Plant

By M. F. Knoy
Lake Charles, La.

UNDER most industrial power rates the demand charge normally constitutes a considerable item in the total power bill. Where purchased power is used, often engineers are able to make substantial savings on the monthly bills by keeping down the maximum demand.

The raw-water ice plant using purchased power is a fruitful field for this kind of effort. And while the total connected motor horsepower in such plants is not great, usually running from 30 to 1,000 hp., still a close study of the demand problem may result in saving as much as $5,000 a year in some cases. In any case, it is interesting and nearly always profitable to investigate the matter.

Of course many ice plants generate their own power, and are thus not so much concerened about the maximum demand. This discussion will be from the viewpoint of those who use purchased power but it is hoped, that some of the points brought out will be of general interest to all.

Many ice plants have a low yearly load factor, that is, the demand for ice in the Winter is only a fraction of what it is in the Summer. To meet the Summer demand it is necessary either to provide sufficient refrigerating capacity to carry the peak load, or to provide a large and costly ice-storage vault.

Use of Season Storage Vault

For reducing the maximum demand the season storage vault is very effective. Under this plan it is only necessary to provide ice-making capacity a little above the average demand and the plant is run under full load practically the entire year. During cold weather the vault will be gradually filled; and during the Summer months stored ice will be used to meet the peak demands. It may be possible in this way to keep the power demand down to only 50 or 60 per cent of what it would be if ice had to be manufactured at the rate of maximum consumption.

Due to the high load factor and to the possibility of making a large portion of the ice in cold weather, the season storage may even reduce the total yearly power consumption per ton of ice made. In some cases, however, it is found that the extra refrigeration required to cool such a large vault the year around, will offset whatever power is saved in the production of the ice. This still leaves the reduced demand charges in favor of the season storage.

While the use of such a storage vault makes possible a great reduction in the amount invested in ice-making equipment, the additional ground requirements and building costs may more than offset this. A great deal depends upon the load factor, building and land costs, energy costs, and demand charge in each case. Each new plant contemplated is a problem of its own, and should be treated as such.

As a matter of fact, many ice manufacturers and engineers have practically abandoned this method of reducing the power demand, and have given their attention to accomplishing whatever they can along this line in plants of low load factor. After all the sole objective of the plant designer is not perfect control of the power demand at the expense of other items of manufacturing costs. What he seeks is the lowest possible over-all manufacturing cost for ice. This, of course, includes not only power cost but labor costs, and carrying charges on the original investment.

When it is once decided to dispense with the season storage, the next step in controlling the maximum demand is a consideration of the points of attack in the low load factor plant. Some of these are concerned mostly with plant design and some with plant operation. The engineer should see that each piece of equipment has a motor of ample size, but not oversized. Where more than one unit of a kind is needed, he should install graduated sizes so as to have an efficient size for each different load condition. It is advisable to stagger the operation of the larger motors whenever possible, and to use every means to avoid running all motor capacity at once. During long periods of low load as many motors as possible should be cut out.

Suit the Motors to the Load

The size of motor required to drive an ammonia compressor working under certain conditions of suction and head pressures can be determined in advance. The same may be said of other motor-driven equipment, such as air compressors, blowers, pumps, brine agitators, hoisting and conveying equipment. In designing a plant one should specify machines just large enough to meet requirements in each case, and motors suited to the machines.

When only one unit of each kind is needed it should not be of excess capacity so that it must operate at a low load factor. For example, there is no need of installing a huge ammonia compressor capacity on a small freezing tank. This not only greatly increases the maximum demand, but results in poor economy due to the low suction pressure resulting from so much compressor displacement working on a small evaporator surface.

If more than one of a kind is needed, the units should be installed in various sizes so as to have a size suited to each of the various load conditions. It would be foolish, for instance, to install a single 400-ton unit in a plant where the maximum refrigerating requirements would only call for this amount. Such a layout would give as high a maximum demand for winter as for summer operation. It would help some to use instead two units of 200-tons capacity each, but better yet to obtain the desired capacity by using a 200-ton, a 150-ton, and a 50-ton unit. One of the larger machines could then be cut out entirely in months of moderate demand, and both larger machines could be cut out entirely under winter conditions.

The problem of pumping condenser cooling water will also bear close analysis. In a large plant having compressor units of various sizes, it will usually pay to have pumping units in sizes to correspond. Thus when only the small compressor is in use only the small pumping unit will be run. This will help considerably in keeping down the demand, especially where pumping is done from a deep well or against considerable static or friction head.

In this connection it may be well in designing a plant to consider the feasibility of using a spray pond or a cooling tower instead of a deep-well pump; especially if by so doing the initial cost of the deep well and the pump could be saved. Of course the cost of make-up water for the cooling system would have to be considered.

Well water usually will be cooler and thus give a reduced head pressure in the hottest weather. On the other hand, during the cooler months the spray pond will furnish the cooler water. Thus, the advantage for the entire year will sometimes be in favor of the spray pond, as it will keep pumping costs low, both as to demand and as to power consumption.

If the source of cooling water is at the ground surface, such as a lake or stream, about all that can be done is to specify pumps suited to the conditions as to volume, and total head, and get the sizes to correspond to the compressor sizes.

Another way to keep down the maximum demand is to stagger the operating periods of the larger motors whenever possible, that is, try to avoid running all motors at the same time. For example, if it is necessary to run a deep-well pump for a short time to get make-up water, see if it is not possible to shut down an ammonia compressor during this time. Or if several ice tanks are in operation and it is necessary to put extra compressor capacity on one of them for any reason, see if it is not possible to take a like compressor capacity off of some other tank temporarily. Again, if cold-storage work is done in connection with the ice plant, the effort should be made to refrigerate the ice tank and the storage rooms alternately whenever possible. If operation is haphazard both systems will sometimes be operating and shutting down simultaneously, thus drawing a maximum demand 50 or 100 per cent higher than is necessary.

Saving Air Compressor Power

Many ice plants reduce the power demand in winter by shutting down certain ice tanks, where more than one is in use. Thus they not only save the usual refrigerating loss from this tank area, but the agitator and blower power as well. This reduction in both energy consumption and maximum demand is often found to pay very well indeed. In the larger ice plants using high-pressure air agitation this would apply especially as here the air-compressor power constitutes a considerable item under conditions of reduced output. I have in mind one such plant that eliminated this difficulty by freezing down all the tank area not actually needed to obtain the necessary output, thus making it possible to agitate the active portion of the tank with a small air compressor provided for the purpose. This reduced the power requirements of the air compressor alone from 30 to 5 hp.

During the summer months the domestic ice consumption fluctuates widely from day to day and from week to week, depending upon weather conditions and other factors. Sometimes when the supply of stored ice has been allowed to run low, there will be a sudden demand and it will be necessary to use all available compressor capacity and force the plant for the time being. An alert and careful operating crew can frequently avoid this difficulty by keeping the storage vault full at all times and watching the weather. When they see indications of a peak demand they fill the storage as full as possible and gradually reduce tank temperatures. In this way they are able to ride over the peaks without having to use an extra compressor.

At any rate, the control of the maximum demand is an interesting problem. Its proper solution will prove profitable in more ways than one; for, besides reducing the power bills, it schools the operating personnel in habits of efficiency and analytical thinking and keeps them on their toes.

Avoid Excessive Water in Turbine Lubricating Systems

By H. L. Kauffman
Petroleum Consultant, Denver, Colo.

"How does water get into a turbine lubrication system?" and "Is the presence of water in the oil detrimental to efficient turbine lubrication?" These are two questions frequently asked the writer by power-plant engineers.

Before commenting upon the question of water in a turbine lubrication system, it might be well to mention the major elements of such a system:

1. Pumps for delivering the oil to the various parts of the system.
2. Oil-drain tanks to which the oil is led after having passed through the various bearings and other parts of the system.
3. Oil coolers through which the oil passes on its way to the system and which keep the oil at the desired temperature.
4. Oil-settling tanks in which the water and other impurities are allowed to settle when there is an accumulation thereof in the oil. The latest design calls for relay tanks but no settling tanks.
5. Oil strainers through which the oil passes on its way to the system and through which it again passes as it re-enters the drain tanks.
6. Oil filters, separators and purifiers, which are used to remove from the oil all water and other impurities not removed in the settling tanks.
7. Piping, gages, thermometers and other instruments, used to indicate the operating condition of the system.

The principal points of entry of water into a forced-lubrication system are as follows:

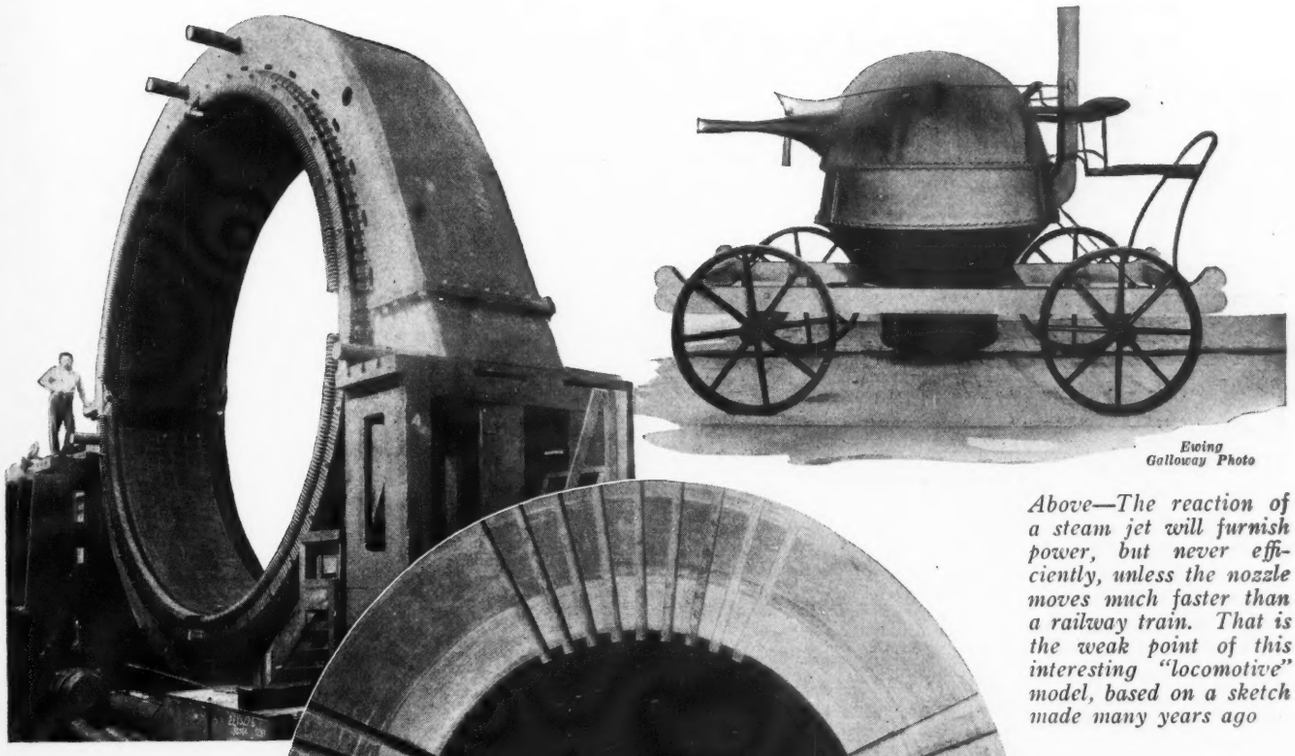
1. At leaky tubes or joints in the coolers.
2. At the steam or water-sealed glands of turbines. It might here be mentioned that care should always be taken that the bilge drain of the pocket, or "well," between the seal and the bearing is clear. A choked drain, in some installations, will permit water partly to fill the pocket and to be drawn into the system via the bearing-oil baffles.
3. Leaky water service for bearings.
4. Through porous water-jacketed bearings.
5. Through vents on the various tanks.
6. As a result of water running down the lubricating-oil pump piston rod from a leaky steam cylinder stuffing box.

The presence of water in a turbine lubrication system is decidedly detrimental to efficient lubrication, and every precaution should be taken to prevent its entry. Water in the oil not only increases the frictional resistance and causes the oil film to break down prematurely, but also tends to corrode the journals.

Industrial High Pressures

High steam pressures are making rapid progress in the industrial field, largely because they increase the possible output of byproduct power. The fundamentals of the problem were outlined last week by P. W. Swain before the Philadelphia section of the A.S.M.E. His paper will be printed in the April 9 number of *Power*.

Engineering—Then and Now



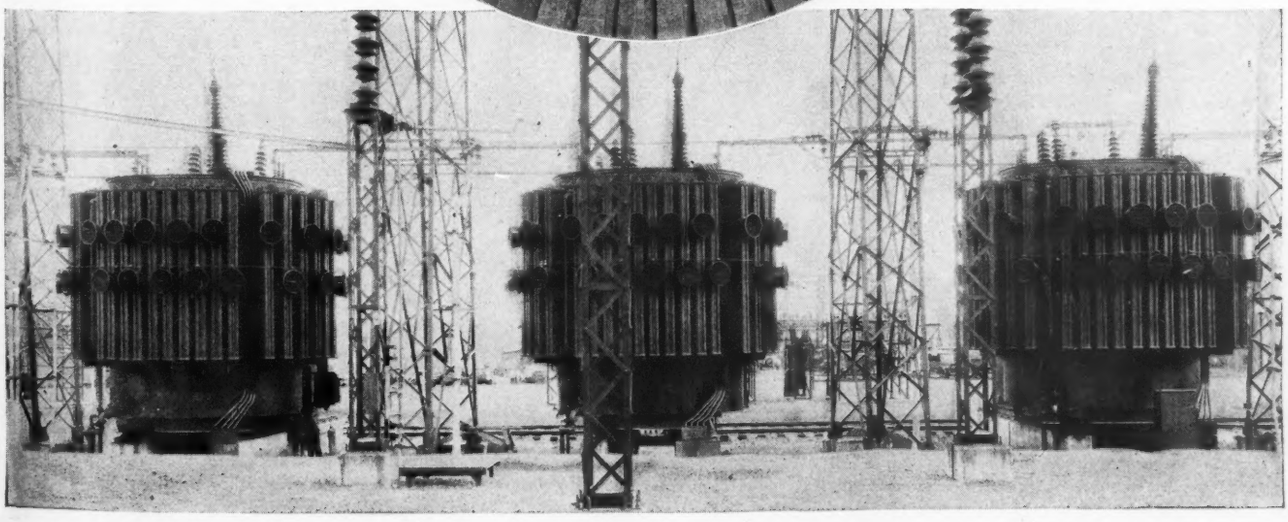
Ewing Galloway Photo

Above—The reaction of a steam jet will furnish power, but never efficiently, unless the nozzle moves much faster than a railway train. That is the weak point of this interesting "locomotive" model, based on a sketch made many years ago

Above — Great power and low speed explain the size of this stator of a 25,000-kva., 143-r.p.m. Allis-Chalmers waterwheel generator

Left—Not the muzzle of some new-fangled giant gun, but a trimmed photograph of the inner portion of a new Westinghouse generator rotor. It is forged from special steel with 60,000 lb. yield point

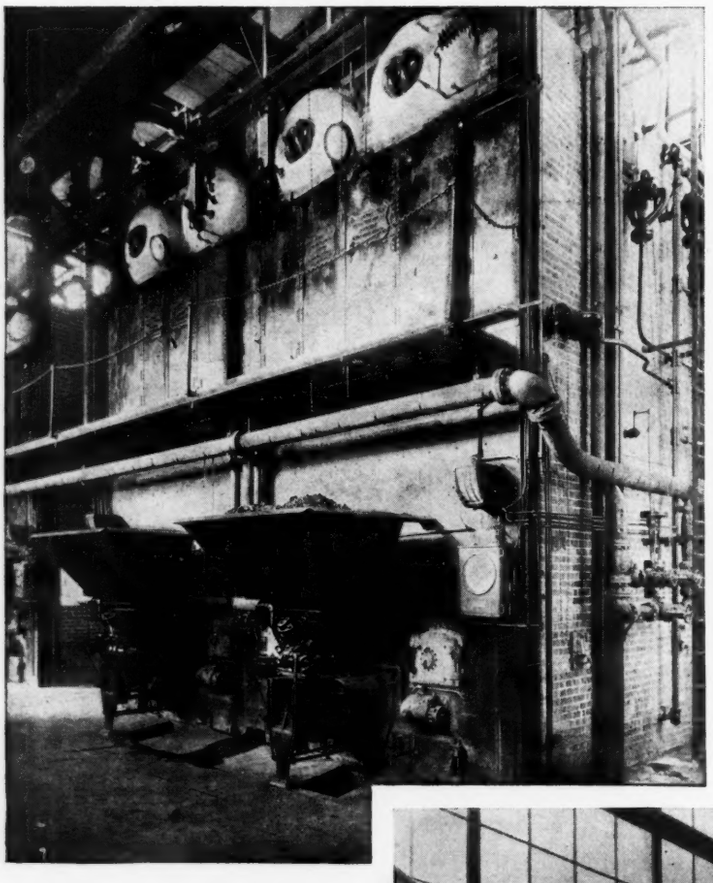
Below — Three 43,333-kva. Westinghouse transformers recently installed by the Philadelphia Electric Company



NEW BOILER PLANT

Serves Coraopolis Refinery of the

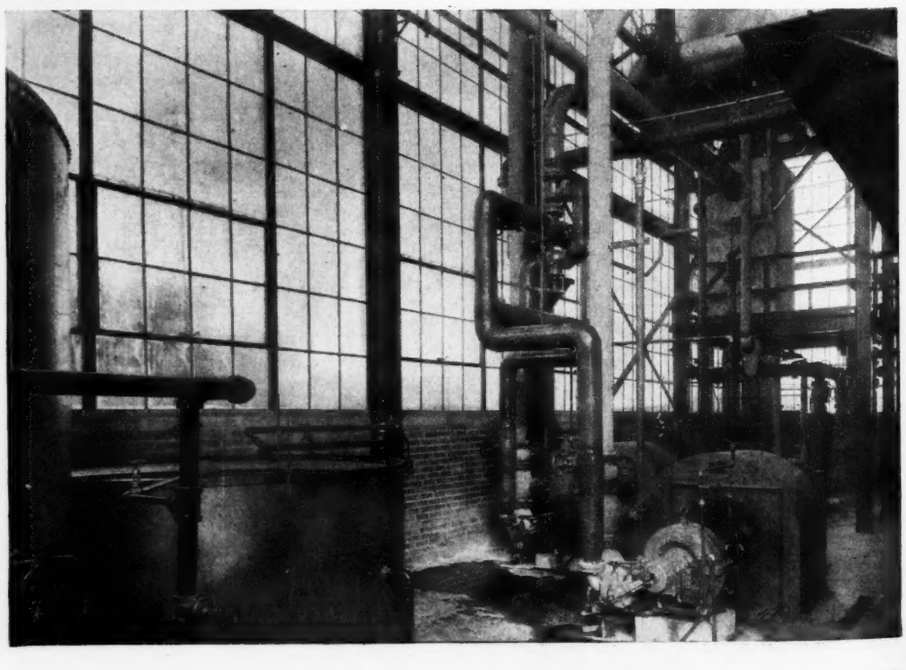
CANFIELD OIL COMPANY



EARLY last summer the Canfield Oil Company decided to build a new boiler plant at its Coraopolis, Pa., refinery. It was felt that the responsibility for design and construction should be confined to one company. After submitting outlined specifications to The Austin Company and receiving its quotation, together with sketches and more detailed specifications, the contract was awarded to that company.

A site was purchased for this boiler plant, adjoining the west end of the Canfield Oil property. The new plant has been completed on this site and connection made to Canfield's steam lines without dismantling the old boiler plant. Load was switched from the old to the new plant without interrupting production. Plans have been made to remove the old boiler plant at once, since the new plant is carrying the entire load.

The Canfield Oil Company refinery at Coraopolis is located along the P. & L. E. R.R. siding, the refinery having been extended to the west to provide carload delivery of coal. A concrete pit was built under the railroad siding with a steel hopper to receive the coal



Above — Two of the three 3,500-sq.ft., longitudinal-drum, straight-tube boilers. With underfeed stokers they are designed to operate at 175 per cent of rating.

Right — Auxiliary equipment includes zeolite softener (left) and two turbine-driven forced draft fans (right). In the background may be seen the open feed heater under the soft-water-storage tank.

from hopper-bottom cars, with a feeder from the hopper to a vertical coal elevator, lifting the coal to the silo storage system of 300-ton capacity. A shelf is provided in the upper part of the silo from which coal is drawn through a spout into the boiler room and into an overhead weigh larry. When the coal on this overhead shelf is exhausted, that in the bottom of the silo can be reclaimed by means of the same elevator used for filling the silo, and dumped into the overhead shelf. Thus it is possible to take advantage of the full storage capacity of the silo.

The weigh larry has a capacity of 1,000 lb. and operates on a track extending along the firing line aisle in front of the boilers. From the weigh larry the coal is dumped into the stoker hoppers, which have a storage capacity of approximately 2,000 pounds.

As the steam load in this refinery was approximately 30,000 lb. per hour, it was decided to install three 3,500-sq.ft. boilers, operating two of these at 150-per cent rating, and holding the third boiler as a spare. The refinery load is fairly uniform for twenty-four hours a day and seven days a week, making spare equipment a necessity.

Longitudinal Drum Boilers Selected

Longitudinal-drum, straight-tube water-tube boilers with vertical baffles were selected as being best suited for the conditions in this plant. Single-retort underfeed stokers with forced-draft equipment were selected for a similar reason. The boilers are fitted with superheaters, designed for 100-deg. superheat when the units are operating at 175 per cent rating. Superheaters were installed because of the long steam lines to the refinery and the need for dry steam for process work.

A reinforced concrete chimney 175 ft. high was built adjacent to the boiler house. The steam generated in this plant is used for process throughout the refinery, and in such a manner that it is not feasible to return the condensation to the boiler house; hence the boilers operate on 100 per cent makeup water.

The Canfield Oil Company has its own water-supply system consisting of deep wells situated on the property. The water is not suitable for boiler work unless treated, so a zeolite water softener was installed to treat all the water used for boiler feed. Water is pumped through the softener to an overhead storage tank and from the storage tank flows by gravity to a deaërating-type water heater. From the heater the water flows by gravity to two feed pumps which feed it directly to the boilers through water-line governors and an excess-pressure governor on the feed pumps.

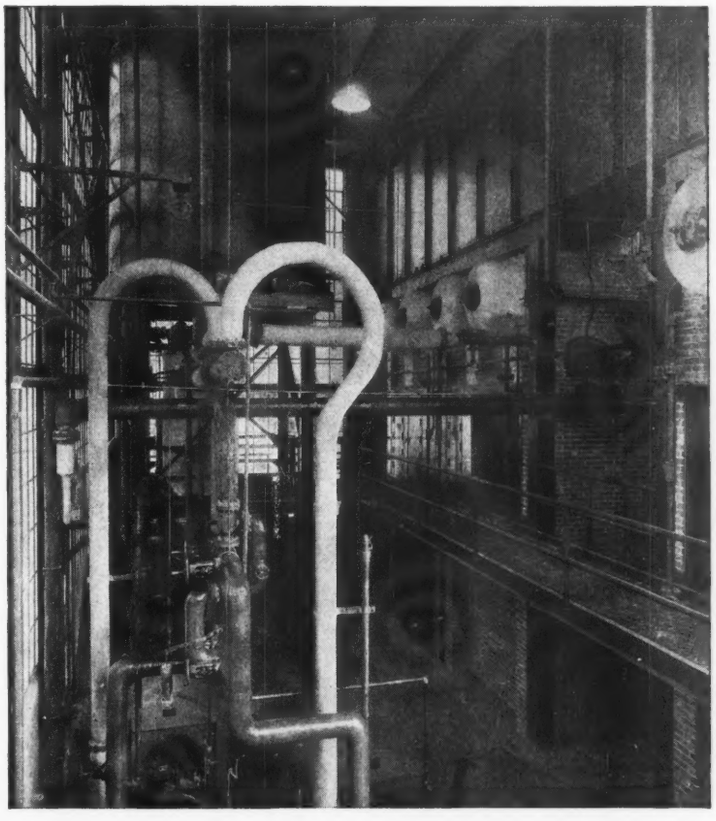
Forced-draft equipment for the boilers consists of two turbine-driven forced-draft fans discharging into an underground duct system to the stoker wind.

Full Line of Instruments Provided

The boilers are equipped with soot blowers, and the main dampers and forced-draft turbines are controlled automatically by a modern type of damper control. Each boiler is supplied with instruments indicating steam flow, air flow, temperature of the flue gas and a three-point draft indicator, showing windbox pressure, furnace draft and uptake draft.

The boiler-house building is a steel and brick structure with steel sash and cement tile roof. All materials entering into the building construction are non combustible and the steel building columns are utilized for the front supports of all three boilers.

This boiler plant was recently turned over to the owner and is now carrying the entire load. While no official efficiency tests have been made, readings taken on boiler instruments indicate that good efficiency is being obtained.



Note soft water storage tank, other auxiliaries and platform giving access to handhole plates in rear of boilers

PRINCIPAL EQUIPMENT OF CANFIELD PLANT

Boilers	Three 3,500-sq.ft., longitudinal-drum, Union Iron Works
Superheaters	100 deg. at 175 per cent rating, Foster Wheeler Corporation
Stokers	Type E Underfeed, Combustion Engineering Corporation
Forced draft fans	(Elliott turbine drive) American Blower Company
Boiler feed pumps	2 simplex, Cameron, Ingersoll Rand Company
Chimney	Reinforced concrete, 175 ft. high x 7 ft. 6 in. inside diameter, Heine Chimney Company
Feedwater heater	Deaerating, 45,000 lb. per hour, Cochrane Corporation
Water softeners	Zeolite 57,000 gal. between regenerations, Permutit Company
Boiler instruments	Bailey Meter Company
Draft Regulation	Hagan Corporation
Feed water regulators	S. C., Swartout Company
Valves	Crane Company and Pratt and Cady
Boiler refractories	Harbison and Walker
Pipe covering	85 per cent magnesia, Philip Carey Company
Coal Silo	300 ton reinforced concrete, Heine Chimney Company
Coal elevator and weigh larry	Industrial Brownhoist Company
Piping	Furnished and erected by Chas. M. Brown Company, Philadelphia

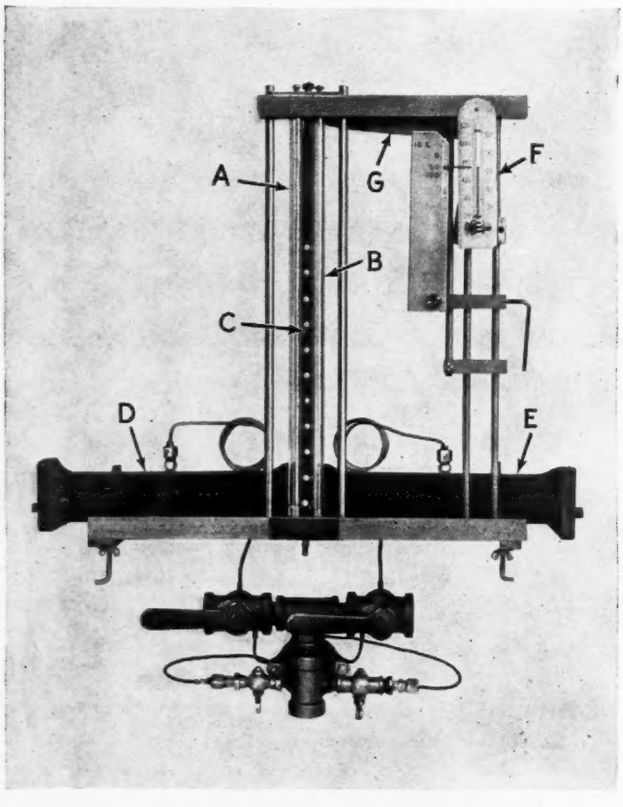
Right Out of the Plant

A Mercury Depth Gage For Water Tanks

THE use of mercury, air and water as the only working elements in the depth gage illustrated, eliminates the possibility of error due to wear, corrosion or friction which is an advantage making it desirable for use as a depth gage for water tanks especially when it is necessary to have the gage remotely located.

The gage was made with two tubes *A* and *B* to indicate the depth of water in two tanks, each of which is ten feet deep. The mercury tubes are $\frac{5}{8}$ in. outside diameter and fourteen inches long. The scale *C* between the tubes is a closely wound coiled spring (as used for closing light doors) $\frac{3}{8}$ in. outside diameter made of 0.045-in. diameter wire which is stretched just sufficient to make each coil represent one inch of water in the tank or approximately 0.0735 in. as indicated by the mercury column.

The graduations consist of pins with white porcelain heads which are easily observed at a distance. They are secured in place by sticking them between the coils of the spring and into a short piece of $\frac{1}{4}$-in. rubber hose on the inside of the spring. The pins are placed twelve coils apart or about 0.883 in. which distance represents one foot of water in the tank as indicated by the mercury.



Assembly of double-tube mercury depth gage

A large mercury surface is presented to the air pressure in the containers *D* and *E*, which are made of tubing $1\frac{1}{4}$ in. square inside and 8 in. long. The containers are pivoted at one end where a hollow trunnion conducts the mercury to and from the glass tube. A leveling screw under the outer end of each container is used for adjusting the height of the mercury in the tube.

The valve arrangement is such that air from the service line passes through a needle valve to a four-way valve from which a $\frac{1}{2}$-in. pipe leads to the bottom of the water tank. The air inlet to the mercury container, being only $\frac{1}{64}$ in. in diameter, is so small as compared with the $\frac{1}{2}$-in. pipe that even though the needle valve be opened to the limit the mercury will not be blown out of its tube.

The amount of air pressure required is just sufficient to keep the mercury container and pipe filled plus enough to make noticeable air bubbles constantly issue from the open end of the pipe at the bottom of the tank, because if water gets into the pipe the gage will show an error.

To compensate for temperature changes a thermometer *F* is mounted on two $\frac{1}{4}$-in. rods and connected by a lever *G*, to the upper end of the graduated scale spring, *C*. A carrier bar with a double point is also mounted on a bar beside the thermometer. One pointer registers the room temperature as indicated by the thermometer and on an inverted scale a number representing the temperature of the water in the tanks.

When the gage is put in service mercury should register on the permanently located bottom pin head or at zero when not under pressure. This zero position can be adjusted by moving the short adjusting screw to which the bottom end of the spring is fastened.

The lever connecting the thermometer and the scale spring should be placed in a horizontal position by sliding the thermometer up and down and locking it with the set screw. One of the pointers is then set to point to room temperature as indicated by the thermometer and locked in position. The temperature of the water is then taken and the number representing that temperature is selected on the inverted scale which is moved up or down so that the opposite pointer registers on that number, after which the scale is permanently locked in position.

With the tank full of water to the ten-foot level and the air turned on and bubbling out at the lower end of the pipe the mercury column should register with the ten-foot graduation on the scale spring, if it does not, it can be made to do so by running the adjusting screw at the top of the scale spring either in or out which action uniformly spaces or recalibrates each of the divisions on the scale.

If there is a change in room temperature the thermometer will register above or below its pointer and necessitate readjusting the mercury scale. This is readily done by moving the thermometer so its indicated temperature is opposite the pointer. The lever ratio is such that when the thermometer is moved one inch the length of the spring is changed about one-tenth of an inch. If there is a change in tank water temperature the inverted scale pointer is set to register that temperature. As this adjustment also moves the thermometer pointer the thermometer must then be moved to its pointer, in so doing the mercury scale is recalibrated for the difference in the weight of water due to the temperature change.

If the gage is adjusted to operate under average temperature conditions and no adjustment ever made to compensate for temperature changes, the greatest error in amount of water indicated would be less than four per cent.

P. J. McCULLOUGH.

St. Louis, Mo.

Going Over the Chief's Head

I HAVE been much interested in the discussions that have appeared recently on the subject of "Going Over the Chief's Head." Personally I do not agree with the opinions expressed by John Moriarity in the March 5 issue. It would appear that he has been rather unsuccessful in attaining the position of chief engineer. The theory of going over the Chief's head does not work out well in practice, as it breeds contempt and demoralizes the plant personnel.

Should any chief engineer be considered unfit to hold office owing to negligence, unwillingness to co-operate or refusing to listen to suggestions offered by the operating engineers, which may lead to better plant operations, he is creating a breech of confidence towards his immediate superior and employer. Conditions of this kind are a matter for the chief's immediate superior to investigate, but under no circumstances should an operating engineer go over the chief's head, for in doing so he too creates a breech of confidence in the eyes of his superior as well as his employer.

It is reasonable to believe that a good many operating engineers are imbued with the idea that the chief stands in his way and in order to make upward progress he should disregard the chief and use unscrupulous methods to attain the goal desired. Unfortunately this method does not work out satisfactorily and he generally finds himself out of a job.

Most engineers appreciate that the chief has an immediate superior who is held responsible for the plant of which he has charge, also that this superior must consider the position of the chief, and cannot afford to listen to subordinates who occasionally have an axe to grind. Should he do otherwise there would be no need for a chief and the consequences would be fatal so far as the morale of the plant was concerned.

I have been in the engineering profession for twenty-one years and a chief engineer for thirteen years, and have always endeavored to encourage the operating engineers, and to welcome suggestions, as well as to educate the plant personnel in the fundamental principles of engineering.

The program recommended in Mr. Moriarity's letter is not ethical and would tend to destroy the morale of any force. The word loyalty does not violate principles and it is not an idle gesture to any right-thinking man who has education, character and principle as well as being trained in his particular occupation. Any man in this country who is prepared, when OPPORTUNITY opens its door, should reach success without violating the principles of loyalty.

It is an old saying that an ounce of loyalty is worth a pound of brains. Whether or not this is true, I do not know; but I do know that most successful employers feel that way. Hence, be loyal. Cultivate loyalty. Stick by the ladder by which you climb up. Never kick it down.

Don't gossip about your employer or any of his associates. Say nothing that you would be unwilling to have him hear. He will forgive you for making mistakes, but he will not FORGIVE disloyalty. Loyalty plays a big part in any successful organization and it also means much to anyone desirous of making a successful career in his chosen profession.

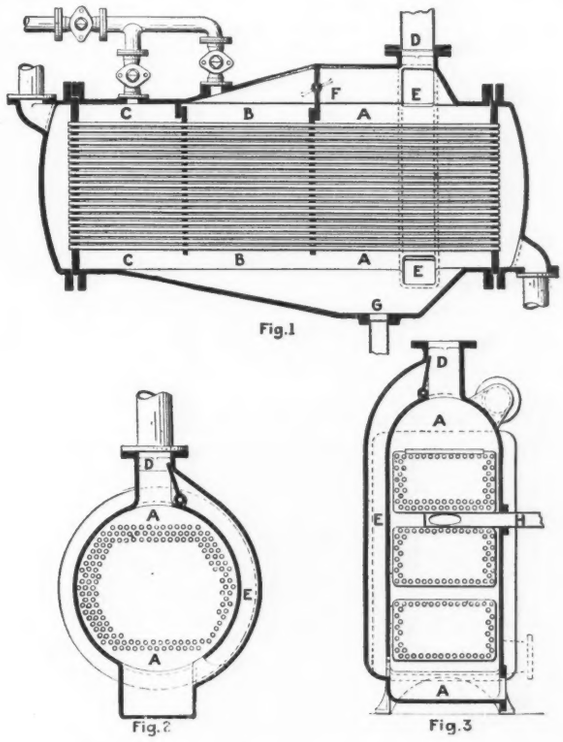
Most men have secured their present positions of trust and power by being loyal to their employers. Most employers select men for promotion, not according to their education, alertness or so-called ability, but according to whether or not they like these men. Now the basis of friendship is loyalty. It can be developed or lost like any other trait. You can train yourself to say and do only loyal things, or you can become careless and indifferent about what you say. By all means, don't try to ride two horses at the same time. Cut out all office politics. Trust your employer absolutely or else resign and go elsewhere.

P. DIAS.

Newark, N. J.

Longitudinal Distribution of Steam in Surface Condensers

In reading the article on "Longitudinal Distribution of Steam in Surface Condensers," by Paul Bancel, in the Feb. 26 number, one would get the impression that he developed the idea of subdividing single-pass condensers into several compartments with independent air removal. In this connection, it would seem only fair to the engineering profession to let them know that these ideas originated with James Weir, Holm Foundry, Cathcart.



Figs. 1, 2 and 3—Reproduction of patent drawings showing method of subdividing the steam

North Britain, who applied for a patent thirty-six years ago. Figs. 1, 2, 3, 4 and 5 of British Patent No. 365 of the year 1893 are reproduced.

It will be noted that the method of subdividing the steam from the turbine, so that it gives up a greater volume and at a slightly higher pressure at the cold end,

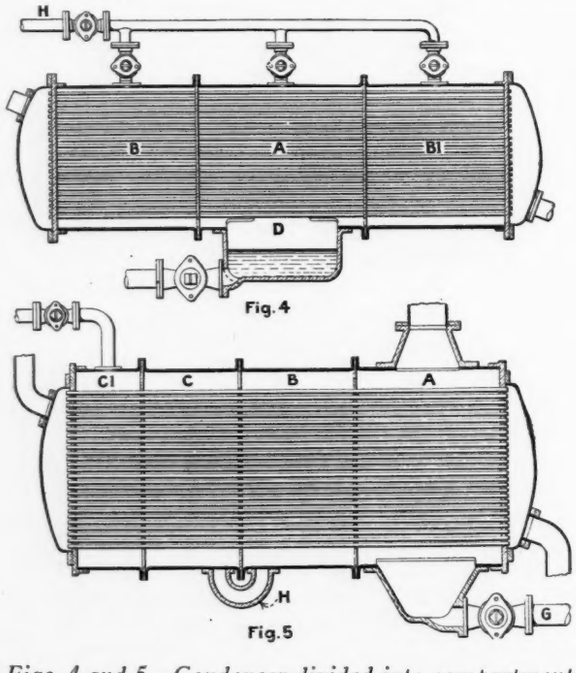
for which method Mr. Bancel advocates the use of a damper, is clearly shown in Figs. 1 and 3.

The division of the condenser into several compartments is also illustrated in Figs. 1, 4 and 5 and the independent air removal is shown in the same illustrations. The separate removal of the condensate is shown in Fig. 5, which illustrates a syphon *H* between compartments *B* and *C*.

Claims are made of all these features by Mr. Weir in his patent, as follows:

1. In a surface condenser, making the condensing space to consist of two or more compartments, passages or ports with valves being provided for distributing the steam variously to the compartments, and separate air outlet pipes with regulating stopcocks being fitted to the upper parts of all or some of the compartments, and an outlet pipe fitted with a stopcock for leading the water of condensation to a pump or pumps separate from the air pump or pumps substantially as hereinbefore described.
2. In a surface condenser making the condensing space to consist of two or more compartments, passages or ports with valves being provided for distributing the steam variously to the compartments, substantially as hereinbefore described.
3. In a surface condenser the condensing space of which consists of one or more compartments providing a passage with a valve for directing the steam into the top or into the bottom of the condenser or a compartment thereof substantially as hereinbefore described.
4. Providing a surface condenser made with one or more compartments, with one or more air outlets fitted with regulating stopcocks and with a water outlet fitted with a stopcock and leading the water of condensation to a pump or pumps separate from the air pump or pumps substantially as hereinbefore described.

Considering the foregoing it would seem that there is little novelty to the features of condenser design as described by Mr. Bancel, although it is admitted that the problem of longitudinal distribution has to be considered, when condenser manufacturers propose tubes of excessive length. Numerous patents have been applied for and granted not only to Mr. Bancel but also to others in connection with this problem.



Figs. 4 and 5—Condenser divided into compartments with independent air removal

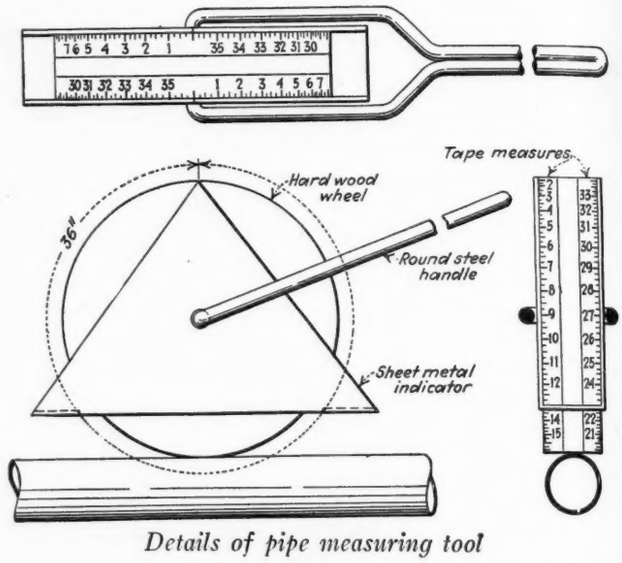
This article also contains other statements which are subject to correction and upon which I may comment more in detail at a later date.

G. L. KOTHNY,
C. H. Wheeler Manufacturing Co.
Philadelphia, Pa.

Handy Pipe-Measuring Tool

RECENTLY, I devised a tool to measure long lengths of pipe. I frequently had to select pipe lengths laid in the yard, and sometimes it was cold enough to make the job uncomfortable when using an ordinary rule and working alone. With the measuring tool illustrated, I can work with gloves and take the measurements in a quarter of the time.

To make the tool, a piece of hardwood two inches thick is turned to give a circumference of one yard. Then two 2-yard tape measures are glued on the wheel, one at each side, with the scales running in opposite directions. Next, a sheet-metal indicator cut to clear the wheel at the bottom and pointed on both sides at the top to indicate the inch marks, is placed over the wheel. The handle is made of $\frac{3}{8}$-in. rod bent to the shape shown and the ends sprung into the hole in the center of the wheel after the indicator is in place. To measure the length of a pipe the wheel is placed at the end with the zero mark on the scales in line with the indicator points. Then the wheel is rolled along the pipe and the number of revolutions and the odd feet and inches noted. The indicator is a loose fit on the handle, so it always points straight up and is not affected by the position of the handle. By running the tape measures in opposite directions, one can push or pull the wheel, whichever is most convenient.



Details of pipe measuring tool

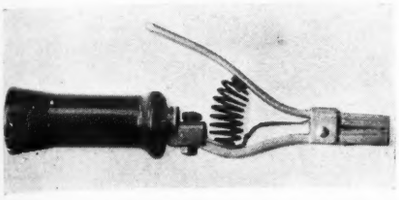
This tool will measure lengths of pipe close enough for all practical purposes, and where one has much of this work to do, it lessens materially the time required over that necessary when using ordinary rule.

Hamilton, Ont., Canada. H. MOORE.

LUBRICATION OF SLOW-SPEED JOURNALS is often more of a problem than that of high-speed bearings, owing to the fact that the oil film is not sustained by a liquid pressure because of the rotation of the shaft, and must depend upon the combined capillarity and viscosity, or body, of the oil. A lubricant of animal or vegetable oils may seem to reduce friction when starting, but as the speed increases and the oil film increases in thickness, the friction will increase. A mineral oil of the same viscosity will reduce the friction below that of the animal or vegetable oils.

What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES



Improved type T electrode holder

New Electrode Holder for Metallic Arc Welding

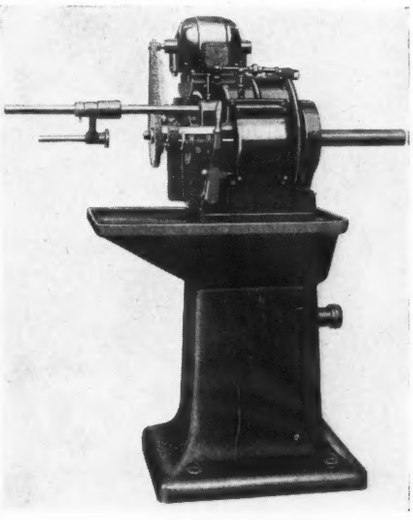
AN improved type of electrode holder for metallic arc welding, known as the improved type *T* and designed for greater operating convenience is announced by the Lincoln Electric Company, Cleveland, Ohio.

The holder consists essentially of a spring actuated clamp to hold the welding electrode firmly while welding and an easy release feature that permits changing electrodes quickly. The handle grip is designed for easy holding, and it is claimed that the holder operates exceptionally cool, because the welding current is carried from the point of cable entry to the jaws by copper strips instead of through the steel frame of the holder as in the older types. The copper tips on the jaws tend to reduce the sticking of the electrode to the jaws, resulting in faster and easier change of electrodes and longer life for the holder. All metallic parts of the holder are coated with non-tarnishing cadmium plating.

New Revolving Head Blade Type Cutting-Off Machine

AMONG the advantages claimed for the new revolving head blade type cutting-off machine, recently developed by the Oster Manufacturing Company, Cleveland, Ohio, are minimum weight, power and floor space required, and the absence of whipping of stock that is not absolutely straight.

The capacity of the machine is $\frac{3}{8}$ in. to 2 in. solid stock and $\frac{1}{4}$ in. to $1\frac{1}{2}$ in. pipe or tubing. The machine is powered with a universal motor operating on 110 volts, single phase, of any frequency between 25 and 60 cycles or 110 volts direct current. With this type of motor, speed is governed by the load put on the machine, and therefore the spindle speed increases inversely with the diameter of the stock being cut off. Furthermore, the functioning of the machine during the return of the blades for the next cut is at the highest speed of which the machine is capable. The motor is provided with a start and stop trigger switch into which



Cutting off machine for solid stock and pipe

is built a circuit breaker, thus protecting the motor from overload.

The drive is from the motor through a silent chain to a jackshaft mounted in roller bearings. The jackshaft carries the speed clutches and drives the spindle, which is also mounted in roller bearings.

The cutter head is provided with two cut-off slides mounted opposite each other in adjustable gibs in the head, and protected by felt wipers. These slides are operated radially by a scroll cam mounted on the head and driven by the jackshaft. The speed of the slides, in and out, by means of the scroll, is obtained by a differential action of the scroll relative to the cutter head. In the slides are mounted, and held by the gibs, the cutting tools, one ground with U.S.S. form and the other flat, the thread shaped tool being set one-half of its vee in advance of the flat tool. The mounting of the tools in the slides is inclined from the radial to give the proper rake, thus requiring only end grinding of the parting tools.

The machine is provided with a universal lever-operated scroll chuck, utilizing two sets of three serrated jaws each operated by a double-sided scroll, and so spaced as to give ample gripping surface and holding power. The machine carries the necessary accessories such as cutting compound pump and reservoir, chip strainer and guard.

Portable Dynamic Balancing Equipment

BASED on the stroboscopic principle, the Davey Dynamic Balancing Equipment illustrated can be used for determining separately the static and dynamic unbalance in machines ranging in size from large turbines to fractional horsepower motors. The apparatus consists of a hand lamp having a special neon tube, a phase adjuster and a vibrometer, as shown in Fig. 1. It is adaptable for use where: 1, it is advisable to balance a rotor running under its own power; 2, when it is advisable to balance at a speed higher than that of the available balancing machine; and 3, where a motor has become unbalanced in

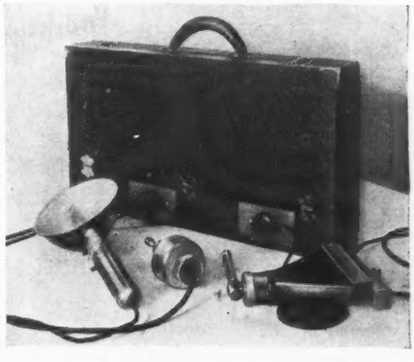


Fig. 1—Hand neon lamp, phase adjuster and vibrometer with carrying case

service, but it is inadvisable to dismantle the machine.

In Fig. 2 the apparatus is shown set up for testing the unbalance of an electric motor and determining the

position and amount of the vibrations. When the rotor is illuminated by light flashes from the neon hand lamp it appears stationary at all speeds. The phase adjuster head is attached to the shaft or driven by it

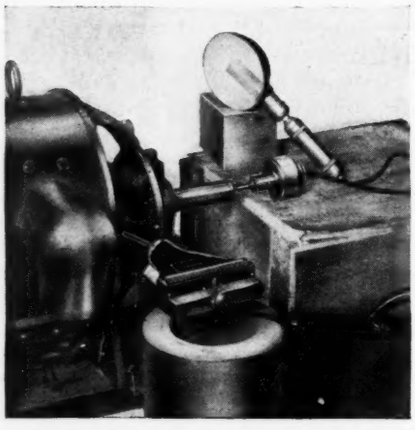


Fig. 2—Device set up for testing motors

the same as a tachometer and it regulates the light flashes so that the rotor will appear stationary at any desired point. The vibrometer arm is placed in contact with the machine frame and indicates not only the amount of vibration but also the position of the frame in its path of vibration with respect to the rotor in its revolution.

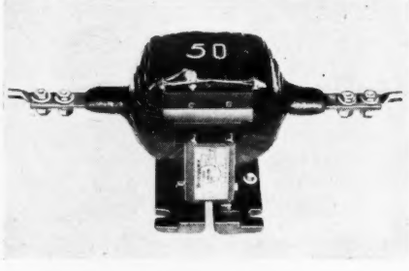
The vibrations of the machine transmitted through the arm of the vibrometer cause a small mirror within the instrument to oscillate. Light from a lamp is thrown on the mirror and is then reflected on a scale magnified several hundred times. Red light from a neon lamp, which is also controlled by the adjuster head, is also thrown on the screen and impinges on the band of white light. As the phase adjuster is turned the red band from the neon lamp will assume different positions along the band of light, and in this way it is possible to determine the exact position of the machine in its path of vibration and to establish the connection between this and the position of the rotor.

By observing the motion of the red light beam on the vibrometer scale, while the rotor is slowing down, a close estimate of the angle of lag can be made. Also, by taking high spot readings at various points along the machine the static unbalance can be separated from the dynamic unbalance and each of these conditions corrected separately. The device is manufactured by the Electrocon Corporation, 6 Varick St., New York City, under the patents of Vibroscope, Inc.

Current Transformer with New Type Steel Core

IN THE new type current transformer illustrated, recently introduced by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., Hipernik instead of silicon steel has been used for the core, giving greater accuracy and lighter weight, for a given capacity. The claims made by the manufacturer for Hipernik, which is an alloy made of pure nickel and electrolytic iron, are that it is non-aging, has three times the permeability of regular silicon steel and one-half the losses. The primary coil of the transformer is wound of light copper strap and in sizes up to 100 amp. is provided with the same terminals which are a copper strap $\frac{1}{4}$x1 in. drilled to take a two-bolt terminal. The primary coil is insulated from the secondary coil sufficiently to withstand a test of 20,000 volts.

End frames of sheet steel are used to hold the laminations together. They are provided with feet suitable for mounting the transformer on a flat



Current transformer with Hipernik cores

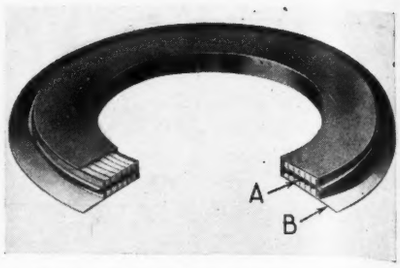
surface, or transverse or parallel pipe frame work by means of standard U bolts. The transformer is available in sizes ranging from 5 to 1,200 primary amperes.

Aluminum Armor Clad Gasket

AN armor clad gasket designed especially for severe service conditions has been introduced by the Flexitallic Gasket Company, Camden, N. J.

The new gasket is the standard Flexitallic gasket *A* encased in a one-piece armor *B* of the sheet aluminum. One flange of the armor is extended to just nicely fit inside the bolt circle of the pipe flanges so that the gasket is properly centered on the pipe opening.

The aluminum armor is sufficiently



Flexitallic gasket with aluminum armor

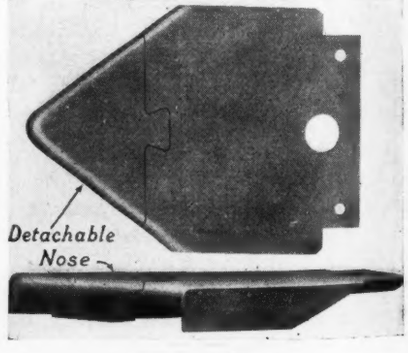
soft to take care of rough or uneven flange surfaces and since it is rust and acid resisting it is suitable for a wide range of applications.

Tuyere for Underfeed Stoker Has Renewable Nose Piece

AMONG the recent important improvements made in underfeed stoker design is the adoption by the American Engineering Company, Philadelphia, Pa. of two-piece tuyeres for use with the Taylor underfeed stoker.

Operating experience has shown that it is generally the nose of the tuyere that burns away while the main part of it remains undamaged. Furthermore, with a one-piece tuyere the complete block had to be thrown away when actually only a small portion of it was damaged. With the new two-piece block illustrated, the renewable nose piece is readily dropped into place without changing the entire block or dismantling the complete row on the side bar. This tends to greatly facilitate the work and lessens materially the cost of renewing the burned sections.

With the adoption of the detachable nose a change was also made in



Tuyere with detachable nose piece

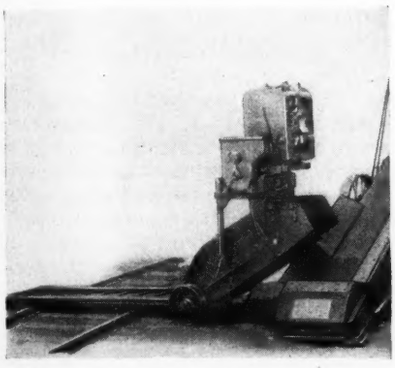
the design of the air ports on the block, small ports being inserted at the front to give a longer life to the nose.

New Light Coal Car Unloader

FOR unloading hopper bottom cars of coal and coke the Barber Greene Company, Aurora, Ill., has brought out the light car unloader illustrated.

The machine is similar in many respects to the unloader described in the March 19 issue, except that it is smaller, having a capacity of 1 ton a minute, and is only $3\frac{5}{8}$ in. thick over the rails, allowing ample clearances for the largest hopper doors. Also, the delivery end of the feeder is elevated so that it can discharge directly into a flight conveyor placed at the same level, as shown in the illustration.

The machine is powered with a gas



Unloader delivers coal from hopper bottom cars to flight conveyor

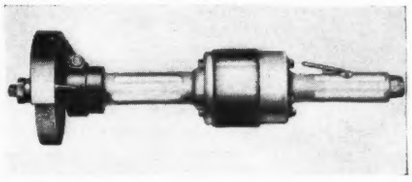
engine or electric motor as desired, and is so balanced that one man can raise one end easily for moving. Its weight is 1,700 pounds.

Multi-vane Portable Grinding Unit

A NEW portable air driven grinder, the "multi-vane," adaptable to a wide variety of services is being put out by the Ingersoll Rand Company, 11 Broadway, New York City. In addition to grinding, buffing, etc., the machine when fitted with wire brushes, can be used for cleaning scale and rust from flat surfaces, ammonia condenser tubes and similar equipment.

The rotor is of hardened steel fitted with four vanes and made a full floating fit on its arbor. The grinder is also fitted with a governor that prevents a grinding wheel or other tool being operated at dangerous speeds. By means of the governor the speed can be adjusted to any desired value up to 6,300 r.p.m. Standard machines are set at 4,200 r.p.m.

An exhaust deflector is used, which also serves as a muffler. It baffles the exhaust air passing through it to remove the penetrating "screech" that is typical of rotary grinders. In addition, the deflector can be turned to



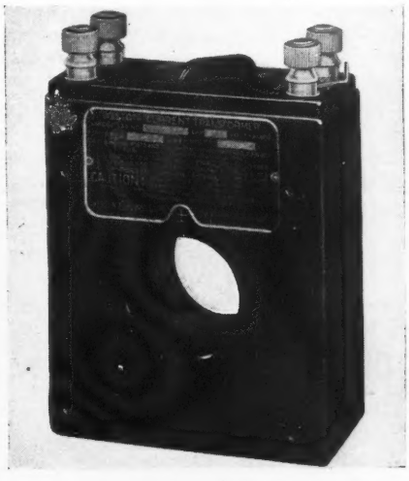
Multi-vane grinder with squeeze type handle

deflect the exhaust in any desired direction.

The wheel-end bearing consists of two radial thrust ball bearings, placed to take thrust from either direction. In the handle of the tool is an oil chamber from which oil is automatically fed into the live air going to the machine every time the grinder is stopped and started. Two types of handles can be furnished; a squeeze-type straight handle or an inside trigger grip handle.

Small Size Current Transformer with Range Changing Switch

A SMALL size, light-weight current transformer, designated model 539, is illustrated. It has a 1-amp. secondary, and when used with a proper instrument, current measure-



Weston model 539 current transformer

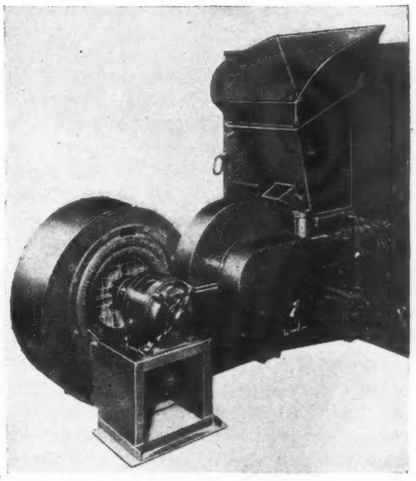
ments can be made from 0.2 to 200 amp. It has four self-contained primary ranges of 2, 5, 10, and 20 amp., which are changed by means of a range changing switch on the top of the transformer. Ranges of 200, 100 and 50 amp. are also available by passing the conductor one, two or four times through the hole in the transformer.

The dimensions of the transformer, which is a product of the Weston Electrical Instrument Corporation, Newark, N. J., are $5\frac{1}{2}$ by $4\frac{1}{8}$ by $1\frac{7}{8}$ in., and the weight is $2\frac{5}{8}$ pounds.

New Drive for Jones Stoker Unit

THE illustration shows a new arrangement of stoker and forced-draft fan drive for the Jones side dump or standard stoker, manufactured by the Riley Stoker Corporation, Worcester, Mass.

Previously, the motor and fan were



Compact arrangement of fan and stoker drive

located close to the stoker front under the ram case with the motor driving the stoker directly through a silent chain. In the arrangement shown, the fan and motor are out in front of the stoker where they are readily accessible, and the motor drives the stoker through the Riflex mechanical drive (described in the Nov. 20, 1928, number) which has a coal feed range between 60 and 6,000 lb. of coal per hour.

With this arrangement the motor and fan can be given better attention, the fireman has more room for handling the fires and a steel plate stoker fan of proper proportions can be used. This drive also lends itself to automatic control, the speed regulating mechanism of the Riflex drive and a damper in the air duct being connected to a regulator operated from the steam pressure.

FROM AMONG THE READERS

Conducted
By
L. H. Morrison

AUTOMATIC DIESEL PLANT.—*We find our power costs high and are thinking of installing a 100-hp. Diesel engine. However, the engineer's salary would amount to almost two cents a kilowatt hour, figuring on a plant factor of 60 per cent for eight hours. Is there an automatic device that would eliminate the need of an engineer?* E.A.R.

It is possible to have a completely automatic plant that will start and stop on a push button control, and also stop in case of failure of the cooling water, fuel oil or lubricating oil. One located in a New York plant works successfully.

It is better to have a semi-automatic plant, with all the safety features of the automatic plant, but using about one hour of a man's time to supervise the engine. The man can do other things, such as machine work, repairing, garage work, etc.

MOTORS CAUSE LOW VOLTAGE ON GENERATORS.—*I have charge of a small plant, which contains one 100-kva. 480-volt alternating-current generator. The average day load is about 30 amperes, balanced on all three phases. There is an electric elevator on the system, that is operated by two 20-hp. squirrel-cage motors. When these motors are in operation the load on the generator is from 70 to 90 amperes. The normal rating of the generator is 120.5 amperes. The motor load may cause the voltage on the 115-volt lighting bus to drop to 85 volts and the voltage on this bus is seldom above 105 when the motors are running. What is the best remedy for this trouble? Would it improve conditions to change the generator's winding for 2,300 volts and use transformers to step down at the load centers?* L.E.O.

It is difficult to give an answer to any problem without all the facts, but from the information given in the question it would not appear advisable to change the voltage of the generator. The induction motors form a very bad load on the generator. This load has a lagging power factor, which tends to demagnetize the field poles of the generator. The demagnetizing effect combined with the voltage drop, due to the resistance of the stator's windings, and the decrease in speed of the unit as the load increases, cause the voltage drop experienced. If slip-ring type motors instead of the squirrel-cage had been installed on the elevator it would have helped some but would not have entirely cured the trouble. The starting current for the slip-ring type motors would have been less and of a better power factor than for the squirrel-cage type. This reduction would have prevented the extreme voltage drop that now occurs when the motors are started. The voltage of the generator would be low with the motors running and with a fluctuating load like an elevator it is impossible to correct the voltage by hand with the field rheostat.

Correcting the power factor of the motors with static condenser, located at the motors, would help to solve the difficulty. It would relieve the generator of part of the starting current and the demagnetizing effects of the lagging current. If the static condenser did not give sufficient relief then and automatic voltage regulator on the generator used in combination with the condensers on the motors should allow maintaining a fairly constant voltage. This problem is one that requires the attention of an engineer familiar with such work.

RATIO OF EXPANSION. — *What is meant by the ratio of expansion in an engine?* S.B.S.

In the operation of a steam engine, the ratio of expansion is the number of times the steam is expanded after cutoff occurs. If there is three cubic feet of steam present at cutoff and this is expanded to nine cubic feet, or three times the volume, the ratio expansion is 3. The approximate ratio of expansion is the reciprocal of the fraction of stroke at which cutoff occurs. Thus, if cutoff occurs at $\frac{1}{3}$ stroke, the approximate ratio of expansion is 3. But the actual volume at cutoff and after expansion includes the clearance volume at one end of the cylinder and must be included to find the actual ratio of expansion. Thus, if the clearance is 5 per cent of the piston displacement, and cutoff occurs at 0.33 of the stroke, the actual ratio of expansion would be

$$\frac{1 + 0.05}{0.33 + 0.05} = 2.76$$

HOW TO FIGURE THE WEIGHT OF ANY GAS.—*Is there a formula by which one can find the weight per cu.ft. of a gas?* W.N.P.

It is convenient to know the constant by which the weight of a cubic foot of any gas may be approximately determined from its molecular weight. At atmospheric pressure (14.7 lb. absolute) and 60 deg. F. the relation is as follows:

Weight per cubic foot = molecular weight ÷ 376

Cubic feet per pound = 376 ÷ molecular weight.

The molecular weights of a few common gases are as follows: Nitrogen (N_2), 28; Oxygen (O_2), 32; Carbon Dioxide (CO_2), 44; Carbon Monoxide (CO), 28; Hydrogen (H_2), 2; Ammonia (NH_3), 17. For air use 28.8 (a weighted average based on four parts nitrogen and 1 part oxygen).

As an example, the weight of a cubic foot of CO_2 at 14.7 lb. absolute pressure and 60 deg. F. would be 44 ÷ 376 = 0.117 lb., and the number of cubic feet in a pound would be 376 ÷ 44 = 8.55.

OVERLOAD ON GENERATOR CAUSES LOW VOLTAGE. — *Two two-phase generators have a normal rating of 340 amperes each, but at times are loaded to 425 amperes. Under the overload conditions the voltage drops ten volts below normal. What is the best way to hold the voltage at normal? The machines are now controlled by automatic voltage regulators.* E.F.K.

Unless the generators are over-rated, they cannot be expected to operate with a 425-ampere load very long without overheating. With this overload on the generators, a considerable voltage drop may be expected, and it may be that the field coils do not have sufficient capacity to maintain the voltage at normal. The power factor of the load will have a marked effect on the voltage. At unity power factor, the generators might be able to maintain the voltage at normal when they are operating with a 25 per cent overload. If the power factor is low, say 65 or 70 per cent, it may be impossible to maintain the voltage of the generators at normal. A lagging power factor load current demagnetizes the field poles.

The only thing that the voltage regulator can do is to apply full excitation voltage to the field coils. If this will not maintain normal voltage on the machine, then the voltage regulator cannot correct the situation. The only remedy is to increase the exciter voltage, if this is possible. If the exciter voltage is increased above normal, careful attention should be given to the generator field coils to see that they are not overheated, or their insulation may be destroyed.

MAXIMUM Co_2 WITH DIFFERENT FUELS.—*What are the maximum CO_2 percentages obtainable with different fuels?* C.B.R.

The percentages will vary with the coal characteristics but average values are: anthracite, 19 per cent; bituminous coal, 18 per cent and fuel oil 14 per cent. These values are, however, seldom if ever obtained in practice.

It is the hydrogen in the fuel that pulls the theoretical CO_2 below the 20.7 per cent for a fuel consisting of carbon alone. Hydrogen burns to water, rather than to CO_2. Bituminous coal contains more hydrogen than anthracite, while fuel oil contains far more than bituminous.

PROBLEMS

ANSWERS

from Our Readers

THE QUESTION

WE HAVE purchased a 400-hp. four-stroke-cycle Diesel and intend to install it in a plant in Denver, Colo. We are told that the engine will not develop its rating on account of the altitude. Is this true, and if so can we do anything to bring its capacity up to its sea level rating? G. S. C.

A FOUR-STROKE-CYCLE Diesel will not develop as much horsepower at high altitudes as it will at lower altitudes. At sea level the barometric pressure is 30 inches of mercury, or 14.7 lbs. per sq.in. At the altitude of Denver, 5,270 ft. above sea level, the average barometric pressure is approximately 24 inches of mercury, or 11.7 lbs. per sq.in. As the weight of air that can be drawn into a cylinder of given dimensions depends upon the pressure of the atmosphere, the cylinder will draw in less air at the high altitude. Thus, at sea level there will be 20 per cent more air drawn into the cylinder than at the altitude of Denver. The amount of fuel burned and consequently the horsepower developed, depends on the weight of the air drawn into the cylinder in a given length of time. At the high altitudes, the horsepower developed will be diminished 20 per cent, or the 400-hp. engine will deliver 320 horsepower.

The only remedy in a situation of this kind would be either to increase the speed 20 per cent, or to use a supercharger to furnish air at a higher density to the air intake of the engine. The first alternative of increasing the speed will in most cases be impractical.

The air supplied per pound of fuel at sea-level conditions is approximately 200 cu.ft. At the lower pressure of 11.7 lbs. per sq.in. this will be 375 cu.ft. to maintain the same fuel-to-air ratio. Ordinarily an engine will consume about 2.6 lb. of oil per minute. This will require 780 cu.ft. of air at sea level conditions or 975 cu.ft. of air at the altitude of Denver.

The work required to compress 975 cu.ft. of air from 11.7 lb. to 14.7 lb. will be 11 horsepower approximately. This can best be accomplished by the use of a centrifugal fan of suitable capacity, one that will deliver not less than 1,000 cu.ft. against a 3-lb. pressure head. MERL D. CREECH.

Oklahoma City, Okla.

IN CALCULATING altitude ratings, the indicated horsepower is generally assumed to decrease in proportion to the barometric pressure, while the mechanical losses, or friction horsepower, are assumed constant.

The elevation at Denver being approximately 5,000 ft., the brake horsepower that normally could be carried would be about 80 per cent of the sea level rating, or 320.

Actually the mechanical losses decrease with the decreasing load, and the fuel-spray penetration increases with decreasing air density in the combustion chambers. Therefore, the engine can be expected to deliver 340 brake horsepower with about the same exhaust temperature and fuel economy as at sea level with 400 horsepower.

Sea-level indicated horsepower can be obtained by supercharging, but sea-level net brake horsepower can be obtained only by overloading the engine to the extent of the net horsepower required for the supercharging blower. The blower free-air capacity can be estimated as follows: Multiply the sea-level indrawn volume of air per minute by the barometric pressure at sea level, and devide by the barometric pressure at Denver. The blower discharge pressure and horsepower is determined by calculation from the known details of the engine and installation. In general, the Root type of rotary blower is preferable for low-pressure supercharging as at Denver, while the high-speed centrifugal blower is preferable only for high-pressure supercharging as in aeroplanes. The blower should be direct-driven where the engine load is nearly constant, and driven by a start-stop electric or mechanical drive where the load fluctuates markedly. When driving the blower from the engine shaft, the possibility of torsional vibration should be kept in mind. R. E. BRUCKNER,

Oil Engine Department
Ingersoll-Rand Company
Phillipsburg, N. J.

I WAS chief engineer of a large Diesel plant located in Wyoming for about five years and this plant had practically the same altitude of Denver. According to theory Diesel engines at this altitude should lose about 15 per cent of their rated horsepower, but the machines developed their full horsepower twenty-four hours a day without any apparent effort. I made quite a few fuel tests and found all of these engines were well within their guarantee. They were of both the solid- and air-injections types.

I found I had to raise the compression in the cylinders in order to get good combustion. I did this by putting shims under the connecting rod end.

Some ten or twelve years ago I installed two 600-hp. Diesels in a mine in Bolivia at an altitude of 14,000 feet. I operated these machines successfully by taking their intakes from an air tank which had had its pressure brought up to about one-quarter pound above sea-level pressure; this pressure was supplied by constant pressure blowers exhausing into an air tank with the capacity of twelve and one-half times the total capacity of the engine cylinders, and the blower had the rated capacity of ten per cent more air at that altitude than the combined capacities of the engine cylinders. I do not remember the details as to the horse-power required to operate these blowers but it was only a fraction of the amount of horsepower lost when these engines took their intake from the atmosphere, which involved a loss of approximately 45 per cent of their rated horsepower.

A series of tests made on these engines showed them to be operating well within their guarantee.

I never experienced any difficulty in getting the full rated horsepower and I feel that if our Denver friends have purchased a reliable make of Diesel they will experience no difficulty in operating them in the Denver altitude.

I. L. STEWART,

Gardena, Cal.

A Question For Our Readers

DESIRING to observe the volume of smoke emitted by our two stacks, without leaving the boiler room, I have thought of employing the principle of the periscope for this purpose.

What is the best arrangement to use? The height of the stacks, from the boiler room floor is 175 feet, distance between stacks 18 feet. J. L.

Suitable answers from readers will be paid for and published in the April 30 issue

The Design and Operation of

High Pressure Stations

AT A RECENT meeting of the Metropolitan Section of the A.S.M.E. two papers were presented. One, by I. E. Moultrop, treated historically the development of the Edgar Station, and the other by R. Brown, related recent operating experiences. *Power* has been privileged to publish many articles describing the additions to this station and therefore only a brief abstract of Mr. Moultrop's paper is given, while the paper dealing with operating experiences has been abstracted more fully. These are followed by an outline of the discussion at the meeting, showing a trend of opinion toward high pressures.

Design Features

By I. E. MOULTROP

Chief Engineer, Construction Bureau
Edison Electric Illuminating Company
Boston, Mass.

SINCE past experience in raising pressures from 90 to 300 lb. had shown that problems due to higher pressures could be readily solved, the Edison Electric Illuminating Company of Boston decided to adopt a pressure of 1,200 lb. for a part of the Edgar Station.

Expectations as to the improvement in economy have been realized, and, furthermore, it has been found that the additional expense of the high-pressure equipment is justified by its greater power-generating capacity. If the design is correct, a high-pressure station need not cost any more per unit of generating capacity than one designed for lower pressures. Mistakes in the design of high-pressure stations are costly, and the necessity for proper design should be emphasized.

The question of whether the use of higher pressures is justified in view of expected higher cost of construction has been raised many times. The reason for this question lies in the fact that many do not realize that we are not interested so much in the cost of a particular part of a station as we are in the cost per kilowatt of generating capacity of the completed station. It is economical to pay more for a few parts, if these few parts will reduce the cost per kilowatt of the complete station.

Because of the discussions regarding the economics of high pressures as compared with normal pressures, some may not realize that high-pressure equipment has already passed from the experimental stage into a period of intensive development. The high-pressure boilers and turbines now being built are of large capacity. Three-spindle, cross-compound, 1,200-lb. turbines of 55,000 kw. capacity have already been built. Fourteen hundred pound boilers capable of carrying a load of 25,000 kw. are in service, and larger ones are being erected.

The turbine-generators in service and on order utilizing steam at 1,200 lb. and above have an aggregate capacity of over 200,000 kw.

The first section of the Edgar Station contained one 1,200-lb. boiler and one 3,150-kw. high-pressure turbine. This unit exhausts through a reheater into the 350-lb. system, comprising three boilers and two 32,000-kw. units. A description of the station, then known as the Weymouth Power Station, was published in the April 14, 1925, number of *Power*. Two 1,400-lb. boilers and a 10,000-kw. turbine have been added to the high-pressure section of the station, and a 65,000-kw. unit to the 350-lb. system. These units have been in operation since September, 1927. Two more 1.400-lb. boilers and a 12,500-kw. high-pressure turbine are now under construction.

The first two boilers have 48-in. diameter forged steel drums with dry pipes of the customary design. The third design has a 52-in. drum without a dry pipe. The saturated steam is taken from this drum at twelve different points, and the result is a material increase in the effective size of the boiler drum. We do not agree with the advocates of smaller boiler drums. The capacity of the boilers should be increased per section, and the boiler drum should be of adequate size. Furthermore, by delivering the steam to the superheater header at twelve different points along its length, much better distribution and a material increase in the effective size of the superheater header is obtained.

The superheater in the first boiler is four-pass across the width of the boiler and is designed for 700 deg. steam temperature. In the second design the superheater is three-pass across the boiler and is designed for 733 deg. The superheater in the third design is four-pass from the bottom to the top, and is designed for 750 deg. Also in the third design the superheater headers are entirely removed from contact with the flue gases.

Steam reheaters in the first two designs are located above the first and second passes of the boilers and below the horizontal circulators. In the third design the reheater is above the boiler, beside the economizer, with a consequent material improvement in accessibility. The reheater in the first boiler is designed for an outlet temperature of 700 deg. and in the second and third designs for 750 deg.

A steel-tube economizer with square boxes connecting the ends of the tubes was used with the first boiler. The second and third designs utilize both economizers and air heaters, and the economizer tubes are hairpin shaped, which reduces the number of joints to approximately one-half the number in the first two designs.

The use of air heaters in the second and third designs required the installation of water-cooled walls on three sides of the furnaces.

As the station developed, the area of the boiler-heating surface has been reduced 54 per cent, while the capacity has been doubled. This means that the heat-absorbing surface has been distributed among the boiler, economizer and air heater so as to get the most economical combination for the steam-generating unit. As the boiler is an expensive item in the high-pressure station, such developments are of the utmost importance, for it is only by study-

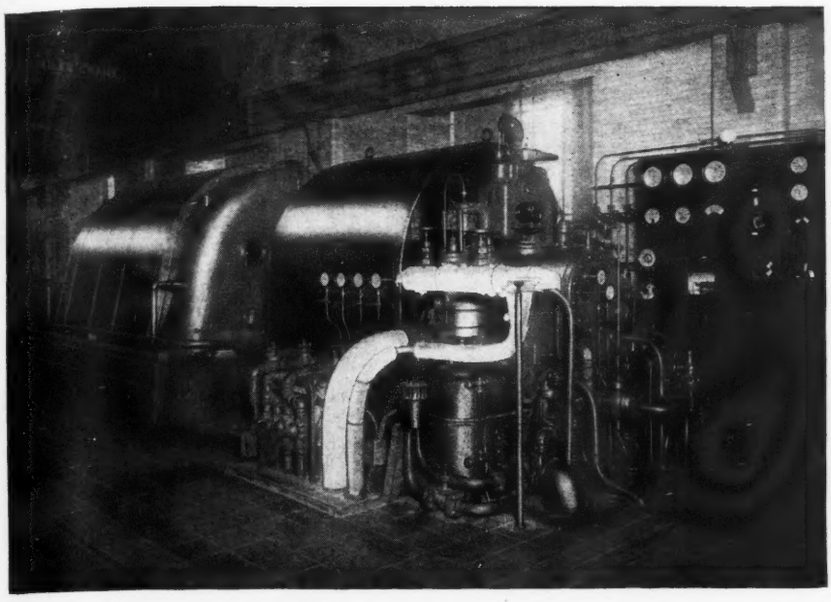


Fig. 1—The 10,000-kw., 1,200-lb. turbine-generator

ing each item carefully that the cost of the station can be lowered.

The first 1,200-lb. turbine-generator has a capacity of 3,150 kw. and is a twenty-stage, single-valve machine. As it was the first unit of its kind, its design is not the most economical in the use of materials or in B.t.u. per kilowatt-hour generated. The second 1,200-lb. turbine rated at 10,000 kw., is also a single-valve machine, but has sixteen stages instead of twenty.

The boiler-feed pump for the first 1,200-lb. boiler is an eight-stage, 3,600-r.p.m. pump designed for a capacity of 300 g.p.m. To keep pace with the increase in the size of the high-pressure boilers and turbines, pumps with a capacity of 2,000 g.p.m. have been designed and are in operation.

Owing to our inability to get a suitable 3,600-r.p.m. motor for driving these pumps, it was neccessary to go to 1,800 r.p.m. This, of course, required more stages, and so the job was accomplished by four pumps in series instead of two, as in the first installation. The primary units consist of two pumps in series and driven by a 625-hp. motor. These units deliver water at 500 lb. through the high-pressure heaters to the suctions of the secondary units.

The secondary units receive feed water at 450 lb. and boost it to the pressure necessary to feed the 1,400-lb. boilers. These units consist of two pumps in series and are driven by 2,039-hp. wound-rotor induction motors.

The motors available for this kind of drive are far from satisfactory. There is a real need for a simple variable-speed alternating-current motor with direct-current shunt motor speed characteristics.

In concluding his paper Mr. Moultrop emphasized: First, that a properly designed high-pressure station can be built for approximately the same unit cost and will show a material improvement in economy as compared with a moderate pressure station; second, that the ultimate in the commercial economy of steam-electric generating stations has not been achieved. It is up to the station designers and the equipment manufacturers to keep up the fight, and by the application of our growing fund of knowledge and cold-blooded economics, to carry on the work of lowering the cost of generating electrical energy.

Experiences with High Pressures

By Richard Brown

Edison Electric Illuminating Company, Boston

THE high-pressure boilers in our recent addition went into service in September, 1927. Since that time we have had a varied series of experiences, not all due to high pressure, but largely to other features of new development.

During the time ruptures were occurring in the superheater, it developed that there existed a hazard in running the boiler pressure considerably under the popping pressure of the superheater safety valves. Under these conditions, in case of sudden loss of load on the station, the superheater valve would not blow and thus allow steam to cool the superheater until sufficient steam had been generated to raise the pressure in the boiler to the popping point of the safety valves. The interval of time required was sufficient for the superheaters to become overheated. It also developed that calculations for high-pressure boilers should be made with allowance for the larger volume of low-pressure steam, so as to permit operation at low pressure.

About the time that superheater tubes were bursting, rear water-wall tubes ruptured just above the ashpit. This was attributed by the manufacturers to faulty circulation due to inadequate capacity in water feeders, recirculators and steam vents from the upper wall header to the boiler drum. The number of feeders, recirculation and steam vent pipes was increased, and we looked for the end of this trouble. Recently, however, after the changes had been made, a similar rupture occurred in the rear wall of the other new boiler.

The theory has been advanced that possibly this last water-wall failure may be attributed to blow-torch action on the wall. In order to prevent a recurrence of this trouble, refractory-faced blocks were installed in place of the cast-iron waffle blocks near the clinker pit on the rear wall. While this measure may be effective, it is also our opinion that variations in water level in the boiler drum change the hydraulic head sufficiently on the wall feeders to unbalance the circulation and cause trouble. This opinion was strengthened when a feedwater regulator stuck, allowing the water level to drop to approximately two inches above the bottom of the gage glass. At the same time leaking was noted in a wall feeder at the point where it is rolled into the drum. In opposition to this theory, however, it has been put forth that this leakage was caused by the sudden increase of boiler feed at this time. Whatever might have been the cause, it is evident that the condition must be remedied.

Bringing a cold boiler into service has been a frequent cause of leaks in water-wall supply tubes where they are rolled into the drum. The theory advanced is that, when bringing the boiler up to pressure, the boiler tubes absorb heat more rapidly than the water walls. This hot water is not drawn from the drum into the water walls, as circulation in the latter has not yet started. Consequently, there is a difference of temperature of approximately 200 deg. between water-wall feeders and boiler drum, causing expansion and leakage at the point of rolling the tube into the boiler drum. This theory is borne out by the fact that artificial circulation induced by bleeding a small quantity of water, while starting up, from the bottom of the wall has caused this trouble to disappear.

Recently, it was discovered that several of the two-inch boiler tubes in the upper bank of the last two boilers had been overheated. One tube was bagged and leaked on one of the boilers, and several others showed signs of distress. Investigation disclosed an exceptional concentration of flame close to the uptake headers, extending to the top of the first pass, which was largely due to the heavy accumulation of slag in the

bottom of the boiler. It produced an unusual localization of heat on the bottom tube of the upper deck. The condition was investigated by the manufacturer, and corrected by diverting water from the lower to the upper bank.

New 1,200-Pound Turbine Experiences

The new 10,000-kw. high-pressure turbine also has given us many new experiences. When this turbine was put in service, it leaked badly at the horizontal joint in the casing. It was sent to the factory and a large amount of metal cut off the flanges to render them more flexible and to permit the use of shorter bolts. When it was opened up after a very few hours service, in order to have the flanges fixed, it was found that one bucket was gone from the last stage. The last four stages were rebucketed with heavier buckets.

After these changes this turbine was again put in operation and has since operated satisfactorily. During the past year this machine ran 3,300 hours out of the possible 8,784, generating a total of 15,684,000 kw.-hr. The exhaust steam from the unit generated approximately 60,000,000 kw-hr. in the 350-lb. machines. The low figure for running hours and kilowatt-hours for the high-pressure unit are primarily due to the development and repair work on the new boilers and stokers. The turbine was approximately 100 per cent available.

This high-pressure unit is equipped, as will be our third 1,200-lb. unit, with a pressure governor that admits steam to the unit in sufficient quantity to maintain approximately 360 lb. pressure in the turbine exhaust. The load on the high-pressure turbine, therefore, is governed by the pressure in the low-pressure main. The low-pressure is held constant also by the Bailey control for the low-pressure boilers. In the original design it was intended that the Bailey control on the low-pressure boilers should come into play after the high-pressure turbines were wide open. However, as the high-pressure part of our plant is not yet 100 per cent developed, we have set the speed governor on this unit for the load that the high-pressure boilers can carry, and allow the low-pressure boilers to take the swings and maintain pressure.

The pressure governor on the present high-pressure unit is set at a pressure above that of the low-pressure main, and will function, in case of a sudden decrease in load on the normal-pressure part of the station, to shut off steam going through the high-pressure unit and prevent the reheater safety valves from blowing. The Bailey control on the fans of the high-pressure boilers maintains constant pressure on the high-pressure steam main, and under the conditions cited, would tend to keep the high-pressure boilers from blowing.

Early in January, 1929, the original 1,200-lb. turbine was opened for inspection. The buckets were corroded and there was considerable deposit in the nozzles as well as on the buckets. Five first-stage buckets were found cracked at the root and were removed, as were an equal number on the opposite side of the wheel to maintain balance. The unit has been closed up and put back in service pending a decision on what is to be done with the rotor. Figure 2 shows the last stages of the rotor at the time of this inspection.

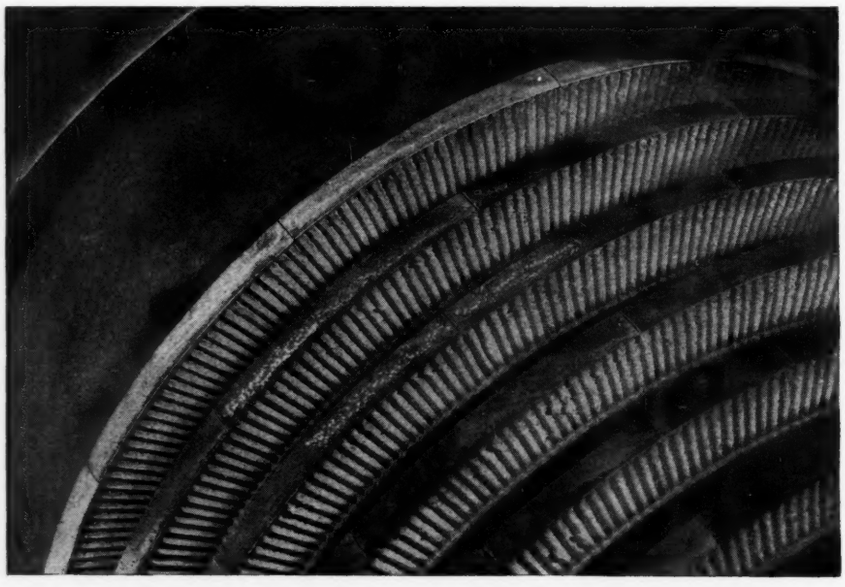


Fig. 2—When the 3,150-kw., 1,200-lb. turbine was opened, considerable corrosion was found in the last stages

1,400-Pound Boiler Feed Pump Experiences

As our experiences have been more varied with the second high-pressure boiler and turbine installation than with the first, so also have been our pump experiences, and since the new installation is of a different pressure from the old, we have not had the pumps of the original installation to fall back on.

The pumps installed with the new 1,400-lb. boilers comprise two units in duplicate, connected in series. The first is a 500-lb. unit taking hot water from the deaërator under low head. The water is first passed through a one-stage booster pump mounted on the shaft of the large pump, which is a volute pump of five stages. The only trouble we have experienced with this unit has been hydraulic thrust wear. This 500-lb. unit discharges water through heaters to a secondary pumping unit consisting of a volute pump similar to the five-stage pump and a six-stage turbine pump. These two pumps, comprising the secondary unit, are mounted on opposite ends of a slip-ring motor shaft.

We have experienced considerable trouble with these secondary pumps. The thrust plates have worn rapidly, but we have been able, thus far, to run one pump long enough to allow us to repair the other and hold it in reserve for approximately two weeks before it is necessary to repeat the operation. In this manner we have been able to keep the plant in operation during our winter load. One of these pumps recently broke its shaft and caused considerable damage.

Shaft Packing a Source of Trouble

Shaft packing has also been a troublesome problem. Various kinds of metallic and other packings have been tried. Metallic packings, that have given satisfactory service on lower-pressure installations, have under these conditions given only fair service. We have a high-pressure extraction heater that takes steam from the exhaust of the high-pressure turbine. This heater delivers water at approximately 420 deg. in normal operation, to the suction of the secondary pumping unit. This hot water accentuated our packing troubles, so we temporarily discontinued the use of the heater.

These pumps have been recently rebuilt by the manufacturer with larger shafts, Kingsbury thrust bearings, and labyrinth shaft packings. At the time of writing the high-pressure heater is in service and the pumps are operating satisfactorily.

In addition to these pumps we have a six-stage 3,600-r.p.m. turbine-driven pump designed to deliver 900,000 lb. per hour from atmospheric pressure to 1,600 lb. per sq.in. This pump was originally intended to take water either from the yard storage reservoir at about four pounds pressure and 60 deg. or from the deaërator under approximately 25 lb. and 250 deg. or, by by-passing the deaërator, from the surge tank at 50 lb. pressure and 150 deg. No booster is used with this pump, and although its operation is satisfactory when connected to either the yard storage reservoir or the surge tank, it fails to operate when taking water from the deaërator. To correct this, several first-stage impellers were tried by the manufacturer without success. A great deal of trouble was encountered due to vibra-

tion, and the bushings in the pump seized on several occasions.

During all our pump trouble it was decided to reset the safety valves on the two 1,400-lb. boilers to blow at the same pressure as the original high-pressure boiler, so that in case we lost all our new high-pressure pumps, we could feed across with the original high-pressure pumps and thus have additional insurance against burning our boilers. As a result of this arrangement we have a high differential pressure across our boiler feed valves and consequently have

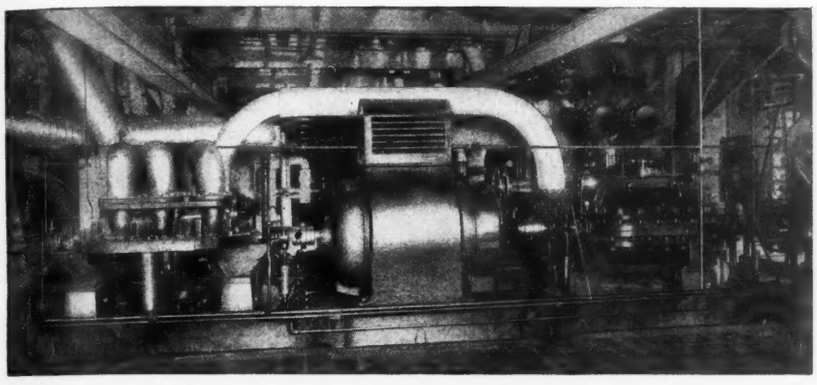


Fig. 3—Secondary 1,600-lb. boiler-feed pump

been compelled to regulate our boiler feed by hand. As soon as our boiler pumps are operating satisfactorily, we shall return the 1,400-lb. safety valves to their original settings and use the feed-water regulators.

Furthermore, it is difficult to obtain satisfactory boiler-feed pressure regulation with electrically driven feed pumps employing slip-ring motors. This is due to the fact that the head capacity curve of a slip-ring motor-driven pumping unit is very steep on account of the well-known speed-torque relation of the motor. This inability to slow down slip-ring motors is a factor, to a slight extent, with normal-pressure equipment. In high-pressure pumps, however, it is a feature particularly noticeable.

Conclusions

A close study of troubles always gives an unfavorable impression of any installation. In general, however, all new departures are certain to have small difficulties that require correction, and in this respect high-pressure steam has not developed any difficulty not readily taken care of. It is, therefore, our conclusion that high-pressure steam for electric power generation is entirely practical, is meeting, and will continue to meet, the efficiencies expected by the designers.

Discussion of Papers

THE discussion of these two papers was extensive and notable in the extent to which various speakers agreed with the authors. Many expressed great appreciation of the pioneer work done by the Edison Electric Illuminating Company of Boston and of the frankness with which Messrs. Moultrop and Brown presented their difficulties as well as their successes.

Such work as this, said John Lawrence, engineering manager of Thomas E. Murray, Inc., has been responsible for the rapid advance in power-plant practice during the last fifteen years. He entered a plea for greater co-operation of users with manufacturers in these developments, since the user profits most from improved economy. Attention was called by Mr. Lawrence to the 1,800-lb. installation that is to be made at the Philip Carey plant, a pressure exceeding that used by any central stations in this country. Greater use of high-pressure equipment, he pointed out, will put it on a production basis and reduce the cost. This in turn will justify still broader application.

Pioneer high-pressure stations have now operated long enough, Col. P. Junkersfeld said, to justify more careful consideration of high pressures in connection with new plants and expansions of existing plants. General confidence in high pressures is increasing rapidly. The superimposed high-pressure unit makes for flexibility since it can be run or not.

Comparing costs presented last year by Mr. Bryden at the Pittsburgh Meeting the A.S.M.E., with some of those in Mr. Moultrop's paper, A. T. Brown, of the Public Service Production Company (New Jersey) said that Mr. Bryden's analysis showed no net saving for a high-pressure plant over one operated at 450 lb. He suggested that the A.S.M.E. sponsor a uniform system of reporting power system costs.

George Orrok, consulting engineer, summed up the results of a questionnaire he had sent last year to the operators of all high-pressure plants in the United States and Europe by saying that no serious operating difficulties can be ascribed properly to the high pressure. His answers included letters from operators of plants at pressures and temperatures ranging up to 3,200 lb. and 930 deg. High temperature, Mr. Orrok pointed out, is quite a different matter, but it does seem feasible to operate high-pressure plants with ordinary open-hearth steel fittings at temperatures substantially higher than the supposed limit of 750 degrees.

One speaker contrasted the situation in industrial plants with that in central stations. He feared that the greater operating care required with high-pressure will militate against its use for industrial purposes, although some of the larger companies, such as the Solvay Process Corporation and the Masonite Corporation are using it with good results. He thought that perhaps American users of high pressures may eventually come to the forced-circulation type of high-pressure boilers used extensively in Europe.

The common idea that the highest temperatures of metal in the fluid cycle are found in superheaters was opposed by E. G. Bailey, who said that the most severe conditions are found in the water walls of furnaces operated at high ratings. This is true, he said, because the water walls have the highest rate of heat absorption, because the vertical position of the tubes causes the film to follow up the tube walls and because scale is more likely to appear at points of high heat transmission. Steam at 1,400 lb. has a saturation temperature of 580 deg. The outer surface of the tube may easily be at a temperature 100 deg. higher, said Mr. Bailey. This introduces differential temperature strains, particularly in the thick tubes associated with high pressure.

In the case of the Boston boilers, said Mr. Bailey, the cast-iron blocks used on the water walls collect a little ash but not much slag. This gives a high rate of heat transfer. Tube failures occurred just above the fuel bed or at points of flame impingement. To overcome previous operating difficulties the cast-iron block has been thickened for high-pressure units to give increased support to the tube. The best remedy, he said, is to protect the tube against excessive high temperature. There is no danger, however, to personnel, as experience has proved. It is merely a matter of reducing outages on the boiler unit.

A. R. Mumford, of the New York Steam Corporation, said that the time has arrived for central stations to pay more attention to the generation of by-product power in connection with steam sent out for district heating. The average building, he stated, requires far more heating steam than power that could be generated from this steam. Mr. Mumford mentioned two 3,000-kw. bleeder turbines with 275 lb. throttle pressure and no superheat, installed by the New York Steam Corporation. These generate a kilowatt-hour for 4,500 B.t.u. By encouraging the purchase of exhaust steam the central stations can reduce the cost of their stations by decreasing condenser equipment.

Economizers can be used to increase boiler capacity, according to Mr. Mumford. These can be protected from corrosion by maintaining the feed water in an alkaline condition. The slightest deposit of scale will start trouble.

R. W. Stovel, of Stevens & Wood, reported progress on the high-pressure installation at the Deep Water station. The initial installation there consists of two 53,000-kw., 1,200-lb. compound units. The estimated cost of the station is $15,000,000. This, however, should not be divided by the kilowatt capacity to give the cost per kilowatt, because the use of the evaporators to supply industrial steam makes it impossible to compare this installation with the ordinary central station. After making due allowance, however, the cost seems to be equivalent to about $106 per kw.

Other things being equal, the speaker felt that the cost of a 1,200-lb. station should not be more than 5 per cent above that of a 400-lb. station, and that such a plant should produce a kilowatt-hour for 12,500 B.t.u. or even less.

A similar report was presented for the new 1,200-lb. Holland Station the cost of which is estimated at from $4 to $5 per kilowatt more than that of a low-pressure plant.

In his closure, Mr. Engle (who read Mr. Moultrop's paper), pointed out that the Edgar installation was not made for scientific purposes but as a straight commercial proposition. He praised the manufacturers for their co-operation. Regarding Bryden's paper he said that it contained errors and should not be used as a basis of comparison.

Mr. Engle emphasized the importance of feeding water to high-pressure boilers at constant temperature. He warned against comparing the cost per kilowatt of a high-pressure station installed at one place under one set of conditions with that of a low-pressure station located elsewhere and operating under different conditions. It was his final conclusion that under similar conditions the cost per kilowatt of high-pressure and low-pressure stations is practically the same. This refers to new plants. Additional capacity, he said, can be obtained at a cost of $74 per kilowatt by imposing high pressures upon normal pressure stations.

Editor's Note—Articles that Power has published describing the design and operation of the Edgar Station.

Weymouth Power Station of Edison Electric Illuminating Company of Boston, April 14, 1925.

The 1,200-lb. Unit at Edgar Station After Six Months' Operation, June 15, 1926.

Operating Experience with High-Pressure Steam Edgar Station, June 7, 1927.

Hydrostatic Tests Determine Boiler Working Pressure, Aug. 30, 1927.

Some Experiences with the High-Pressure Boilers at Edgar Station, March 13, 1928.

Story of the First Commercial 1,200-lb. Steam Plant, April 24, 1928.

Four Years of Progress in High-Pressure Boiler Design, Aug. 14, 1928.

Research Activities of the A.S.M.E.

By A. A. Potter

Dean of the Schools of Engineering and Director, Engineering Experiment Station, Purdue University.

THE American Society of Mechanical Engineers is aiding research in the United States by acting as a clearing house for the dissemination of research information, by eliminating duplication through co-ordination of existing research projects, by assisting in the education and training of research workers, by organizing for co-operative effort in research problems, and by supporting directly certain investigations.

These activities are organized and directed by a standing committee, officially known as the A.S.M.E. Main Research Committee. Since 1918 about $35,000 has been expended by this society in other research activities. The success of these methods is attested by the fact that during the same period $173,000 additional has been raised from industry for investigations under the direction of the A.S.M.E. Main Committee. The researches of particular interest to the power industry, include the following:

1. Lubrication. A study was authorized in October 1915 to determine the fundamental problems of lubrication phenomena, to formulate the results of investigations previously made, and to keep in touch with contemporary research in this field. The experiments involved lubricants at high pressures and temperatures; a study of journal bearing lubrication leading to the development of practical bearing data; also experiments to test the theory of lubrication. The U. S. Bureau of Mines, the Westinghouse Electric & Manufacturing Co., and the Pennsylvania State College have been co-operating in these studies. The publications to date include the following papers which have been printed in *Mechanical Engineering:*

"Viscosity of Lubricants Under Pressure."

"The Effect of Running in on Journal Bearing Performance."

"An Investigation of the Performance of Waste-Packed Armature Bearings."

"Journal Running Positions."

"Friction of Journal Bearings as Influenced by Clearance and Length."

2. Fluid Meters. With the co-operation of meter manufacturers a study was undertaken in 1916 to develop the theory of fluid meters. Part 1 of the published report which deals with the theory and application may be purchased from the A.S.M.E. During the past year Parts 2 and 3 have been completed.

3. Fuels. Objectives are to co-ordinate present research efforts, to collect data on fuel research and to study certain specific fuel problems. The publications of the A.S.M.E. committee to date is a paper on, "The Need for Coal Research" by F. R. Wadleigh, presented at the Natonal Fuels Meeting of the A.S.M.E. in Cleveland, 1928.

4. Properties of Steam and the Extension of Steam Tables. This study was started in 1921 to check the present steam tables and to determine constants for higher temperatures and pressures. About $72,000 has been contributed by industry for this investigation, which has been carried on simultaneously at the Massachusetts Institute of Technology, Harvard University and the U. S. Bureau of Standards. The results of this investigation were reported in *Mechanical Engineering* for February 1929. In this number will be found data for steam up to the critical temperature of 3,200 lb. per sq.in; also results of investigations in Europe that corroborate the studies made under the auspices of the A.S.M.E.

5. Boiler Feed-Water Studies. Methods of analysis and treatment of boiler feed water are being investigated. Preliminary surveys have been made of the various phases of the problem and the results indicated that the following require research: (a) the corrosion of boilers and auxiliary equipment, (b) priming and foaming of feed water, (c) embrittlement of boiler steel, and (d) determination of the efficiency of evaporators and deaerators and their function in reducing feedwater troubles.

6. Boiler Furnace Refractories. The factors governing the failures of refractories in various types of installations are being studied. The laboratory phases of the program are being investigated at the Engineering Experiment Station of the University of Illinois and at the Ceramic Laboratory of the Bureau of Standards at Columbus, Ohio.

7. Condenser Tubes. An investigation was authorized in 1925 to determine the causes of failure of copper alloy tubes in condenser and other heat interchange apparatus in which steam and water are handled. A report on the "Geographical Location of Bad Condenser-Water Conditions" was published in *Mechanical Engineering* in February 1928. In the May 1928 number the project of the "A.S.M.E. Special Research Committee on Condenser Tubes" was explained. At the annual meeting on December 5, 1928 a progress report was presented dealing with the effect of design and operating conditions on condenser tubes.

8. Effect of Temperature on the Properties of Metals. This study is being undertaken in co-operation with the American Society for Testing Materials. Elaborate tests are being conducted in co-operation with about twenty industrial, educational and government laboratories.

9. Absorption of Radiant Heat in Boiler Furnaces. The objective of this investigation is to develop useful design data for furnaces.

10. Diesel-Fuel Oil Specifications. This study is being undertaken to establish uniform specifications for oil intended for use as diesel engine fuel.

[The article in the May issue will deal with "The Mellon Institute of Industrial Research."—Editor.]

Mechanical Engineers Meet at Knoxville, Tenn.

IN VIEW of the remarkable development of Eastern Tennessee industrially, it is not surprising that the regional meeting of the American Society of Mechanical Engineers, held at Knoxville, on March 21-23 should have been attended by over 300 engineers.

Tennessee is unique in that it is the third state in coal production and possess water power, developed and undeveloped, of over three-quarters of a million horsepower. The variable flow of the rivers necessitates the construction of steam plants as a reserve against water shortage, and according to some engineers, the low cost of Tennessee coal makes a steam plant more economical than water power.

Consequently the sessions exciting the most interest were those devoted to steam power, to water power and to the problem of domestic fuel.

Meetings of the various engineering societies are generally attended by older members, with but a faint sprinkling of students. The Knoxville meeting, on the other hand, seemed to have been dominated by technical students. Engineering seniors from as far away as Florida University lent a youthful but earnest atmosphere to the various sessions, to the distinct advantage of all.

Factors in Furnace Design

At the Thursday morning session the first paper presented was that dealing with factors in the design of boiler furnaces. This was presented by Prof. F. C. Stewart, of the Georgia School of Technology, Atlanta, Ga. The following brief abstract covers some of the high points of Professor Stewart's paper.

The volatile matter of both bituminous coal and lignite is high. This volatile is very difficult to burn owing to the fact that it tends to pass out of the furnace with the flue gases before combustion is completed. Effective burning of volatile gases has been accomplished in two ways. The first, which is used with great success with bituminous coal, is to introduce the fuel from below the burning fuel bed as is done in the cases of underfeed stokers. The second method, which is used with both lignite and bituminous is to provide drying and ignition arches and other heat reflecting surfaces which will distill off the volatile and cause it to pass over the high-temperature burning fuel bed.

The heat liberated on stokers for different fuels is as follows: Lignite, 15,000 to 25,000 B.t.u. per cu. ft. per hour, bituminous, 20,000 to 50,000 B.t.u., and anthracite, 25,000 to 50,000 B.t.u.

The underfeed stoker is a successful device for burning bituminous coal. This fuel is heavy enough to stand high drafts and in most cases the ash has a fusion temperature so high that excessive clinkering does not occur. The tendency of ash to accumulate on the first row of boiler tubes can be eliminated by increasing the height of the setting or by making a water screen of alternate rows of the lower tubes of the boiler.

Benefits of Water Walls

Development of large-capacity furnaces was made possible only by the improvement of the types of wall construction used. In the early stages of development, furnace volumes were made large and the turbulence kept low in order to keep the refractory walls as far from the burning fuel as possible. This did not make efficient use of the furnace volume.

Air-cooled refractory walls were next introduced. The next step in the development of furnace walls was the application of water-cooling which is responsible for the success of the modern large-capacity furnace.

Perhaps the most important of all the advantages of the water-cooled wall is the reduction in furnace maintenance with the resulting decrease in boiler outage.

Higher rates of heat liberation, with added increase in capacity of a given sized furnace, makes possible the utilization of larger steam generating units, with resulting savings in the size of the building required to house a plant of given capacity.

Moreover the water walls actually increase the capacity of the steam-generating unit from 15 to 30 per cent, although the actual heat absorbing area of the water wall is only two to ten per cent of the boiler heat-transfer area.

Stoker-fired furnaces using bituminous coal may have heat liberation rates from 35,000 to 50,000 B.t.u. per hour per cu.ft. The higher the volatile content the lower the heat liberation rate. Stoker-fired lignite furnaces cannot be successfully operated at heat liberation rates much over 20,000 B.t.u. with natural draft and 25,000 with forced draft.

In discussing the paper Geo. Orrok stated that when a fin-tube water wall is used it is possible to develop 650 per cent boiler rating, and mentioned that the East River station, New York City, has all water cooled furnaces.

Just how much heat can be released per cubic foot of furnace volume is hard to state. With hand firing probably 10,000 B.t.u. is high while with stokers the limit increases to from 40,000 to 50,000; with pulverized coal the release is about the same. On the other hand when burning oil records of over 75,000 B.t.u. per cubic foot of furnace has been attained, and if one considers the volume to be made up of the "cone" of combustion, which has a base diameter of about 30 in. and a height of 7 ft., the release can be well over 180,000 B.t.u. With a Lodi burner it is possible to burn 3,000 lb. of oil per hour in a Scotch marine boiler. This, Mr. Orrok claimed, upset the old idea that water cooled furnace walls chill the fire.

The discussion was followed by the presentation of two other papers and their discussion. Factors in the design of the new Gorgas steam plant of the Alabama Power Company were outlined by Prof. John M. Gallalee of the University of Alabama. A brief abstract of his paper follows.

New Gorgas Plant

With the knowledge that an additional steam plant must be ready to run in 1929, a decision had to be made in 1927 on the type and on the location of a plant to deliver to a load center or load centers the necessary energy at the lowest total cost in fixed charges, fuel, operation, maintenance, transmission lines and line losses. Studies indicated that the capacity factor of the new steam plant would not exceed 40 per cent over a period of 15 years.

It was decided to locate the new plant on the Warrior River not far from the old Gorgas steam plant. This location is near a coal field and at a suitable point for distribution and condensing water was available.

Before selecting the pressure, preliminary estimates were made for three cycles: 450 lb., 650 lb. with boiler reheat, and 1,400 lb. with boiler reheat. In all three cases steam temperature is 725 deg., the vacuum 28 in., and feed water is heated from 3 bleed points.

The studies show that the three plants could be built for $95.50, $105.30, $106.90 per kw., respectively, while the corresponding net heat consumptions per kilowatt-hour are 16,000, 14,800 and 14,200 B.t.u. Using the assumed capacity factor of 40 per cent, the 450-lb. plant comes out better than the 1,400-lb. plant, with the 650-lb. plant a bad third. Therefore a pressure of 450 lb. at the turbines was selected.

Equipment already purchased includes two 30,320-sq.ft. Babcock & Wilcox cross-drum boilers for 475 lb. pressure, with water walls; three 15-ton Raymond

mills, sixteen Combustion Engineering No. 7.5 cylindrical burners and two 30,600-sq.ft. plate-type air heaters.

While pulverized coal figured out best for this plant, the designers have no prejudice in the matter and have selected stokers for a smaller plant in another location in Alabama. The new Gorgas plant is scheduled for completion in May, 1929.

Powdered Fuel for Standby

In his paper "The Use of Powdered Fuel in a Standby Station," H. H. Bailey, superintendent of production, the Tennessee Electric Power Company explained the remodelling of his company's Nashville, Tenn. station. The Nashville Station has been used as a standby plant for some time, although during certain periods it is operated at a moderate rating for from 12 to 18 hours daily, and for a few months yearly is run at maximum load continuously.

When additional boiler capacity was required in 1927 the company decided to install pulverized coal equipment. Briefly the new installation consists of two 14,510-sq.ft. boilers with water-cooled furnace walls, superheaters and air preheaters. Each boiler has two impact unit mills, each mill feeding a single burner. Unit mills were selected by reason of their lower first cost, space limitations and the impracticability of using a bin system in a standby plant.

At times these boilers run 24 hr. a day, but on Sundays and holidays no power is required from Nashville and only a house turbine is operated on steam from one of the older stoker-fired boilers. It has been found that the powdered-coal boilers could not be used on such light loads.

In usual operation the output of the plant ranges from 40,000 to 175,000 lb. of steam per boiler, the peak coming with suddenness. The change in furnace conditions can be made almost instantly. A powdered-coal boiler is brought into service in 10 minutes if it has been off only during the night. If dead cold, the boiler is given from 20 to 25 minutes to steam up.

When the operator receives an order to start a boiler he opens the uptake damper inserts a kerosene torch into the furnace with the flame directly in front of the burner. He then starts the pulverizer, and as soon as one burner is lighted he proceeds to start the other one. If the furnace is warm the burners will light immediately, but if the furnace is cold, the torch must be kept at the burner for several minutes. The two boilers can be handled by one man, although a helper is on duty as a precautionary measure.

The pulverizer hammers have an average life of but 500 tons. New hammers are now being tested and indications are that they will have a life of about 2,000 tons. After passing 700 tons, it was found that the hammers gave a coal fineness of 70 per cent through a 200-mesh seive and 99.5 per cent through a 28 mesh. The fineness depends somewhat on the surface moisture of the coal and can be controlled in a limited way by adjustment of the hot-air flow through the mill.

Pulverizer maintenance was excessive at first, being about 15 cents per ton, but this has been reduced to seven cents and there is hope of bringing it to five cents. This latter figure is the cost with stokers.

No dust collectors were installed, and as there have been some complaints, experiments are being made with water jets in the stack. As the water combined with the flue gases is highly corrosive, the stack shows some deterioration. It is proposed, therefore, to water proof the stack lining and use the water jets.

Discussion of Gorgas Paper

The discussion of Mr. Gallalee's paper centered around the question of steam pressure.

Paul Wright stated that in his opinion a pressure of 350 lb. with bleeder heating of the feed water is the best pressure for the industrial plant. This type of condensing plant can be built for $100 a kilowatt. He felt that in the furnace design engineers fail to consider local conditions and local fuel. Too many existing furnaces are copies of designs quite suitable where anthracite is burned, but utterly impossible for plants where high-volatile bituminous coal is the fuel.

C. A. Biggs, Knoxville, expressed surprise that the air pre-heaters in the Nashville plant have given no trouble, as by-passes are not used. It was his experience that a by-pass was necessary.

In discussing the question of the most economical steam pressure, F. Jackson, Southern Power Company, had made investigations as to costs and had decided upon 450 lb. He inquired concerning the yearly load factor of the Gorgas plant and was informed that it will be about 40 per cent. Mr. Jackson stated that, if the total operating costs of the 450 and the 1,200 lb. steam plant be plotted against coal prices, the two cross at three dollars a ton. This point was the same in the case of two entirely different plant studies.

A general running discussion took place on the subject of plant costs. Several expressed doubt as to the possibility of building a plant for $95 per kilowatt capacity. Geo. Orrok said that plant costs are a plaything of the designer; plants have been built for $50 and others for as high as $280 per kilowatt. In fact since 1880 there has been little change in the unit cost of power plants. In the earlier years the cost was in the boiler and engines. Now with high boiler outputs and turbines of low steam consumption, the greater portion of the installation cost is due to the auxiliaries, but still the plant cost $100 as in 1880.

In his closure, Mr. Gallalee stated that, for the conditions in Alabama, the 450-lb. plant is undoubtedly the most economical.

At the Thursday evening session the papers on low-temperature carbonization were greeted with interest, since the South depends upon bituminous coal and the smoke problem is a serious one.

The "Domestic Fuel Problem as Modified by Low-Temperature Carbonization," was the title of a paper by Geo. Orrok. The author pointed out that the increase in the urban population has made the smoke-problem solution imperative. Tests indicate that the domestic chimney is the chief offender, and low-temperature carbonization of coal was advanced as the solution. A brief description of such a plant was given, differing in no general way from prior descriptions in various technical publications. Of interest, however, was the statement that such prepared fuel can be sold for $9 a ton.

Laboratory tests indicate that Tennessee coal, when subjected to low-temperature carbonization, yields a good semi-coke and a long list of by-products.

L. H. Morrison observed that engineers speak of high volatile gases in the sense that the hydrocarbons are held as gas in the coal. To the contrary, the gas forms upon heating, and the smoke is produced by those hydrocarbons that distill off at a low-temperature, a temperature far below the ignition point, and smoke results. In low-temperature carbonization these low-temperature hydrocarbons are removed and the coke burns clear even though it does contain 15 per cent of high-temperature distillation hydrocarbons.

Survey of Tennessee River

The remaining paper in which power engineers were interested was that presented Friday morning by Prof. J. A. Switzer on "The Survey of the Tennessee River System by the Engineers Corps." In 1926 the total installed power capacity in the Tennessee River Basin was 660,000 kw., of which 360,000 kw. was hydro-electric and 300,000 kw. was steam. The total demand of electric power during the year was 1,100,000,000 kw.-hr. When the entire system of flood control and water power is developed there will be a yearly possible output of 22,600,000,000 kw.-hr. At 50 per cent load factor there will be required an installation of 4,777,800 kw. of steam power. Over 40 per cent of the projects will create water storage, and the plan is to so control the water that the maximum flow through the water wheels will occur during the low-water period in summer. The advantage lies in the elimination of steam-standby plants so necessary when no storage exists.

Other activities included visits to the Fulton Company's plant, the plant of the Clinton Hosiery Company, to the Kingsport industries and to the Smoky Mountains. The engineering Department of the University of Tennessee held its annual exhibition and also its St. Patrick's celebration at which various honor students received knighthood.

Handling of Solid Fuels by the User

Factors Affecting Installation—Railway Car Unloading—Feeding—Elevating and Conveying are discussed in this abstract of a paper presented at the World Power Fuel Conference

By R. K. STOCKWELL

SO MANY types of equipment have been developed for handling of coal and coke, and their functions so overlap each other, that it is difficult to choose the most suitable for a given problem without a wide experience in their uses and limitations. The user is faced with the problems of unloading his fuel, transporting and elevating it to his bunkers, and storing and reclaiming. Occasionally, with a small plant and suitable conditions, one machine will perform all these duties, but generally a combination of several machines is necessary.

Where coal is received in bottom-dump railway cars the track hopper is perhaps the best method of unloading for plants in warm countries, where severe winter conditions, that sometimes make this method so difficult due to freezing the coal solid in the cars, do not exist.

For most efficient unloading the track hopper should not be used for storage but only as a quickly self-cleaning transfer chute. Its containing capacity depends on the amount of coal to be handled. The removal of the coal from the track hopper to the elevating and conveying system should be by means of a positive, power-operated feeder, with capacity control regulation.

Car dumpers turn the railway wagon nearly upside down and discharge the coal to a hopper, from which it is removed by a suitable feeder at any desired capacity to the elevating and conveying system.

The feeder is a vital unit in most coal or coke-handling plants. It regulates the discharge of the material and feeds it to the conveying system in such a manner and at the required capacity to work the conveyors to their highest efficiency by keeping them fully loaded, but never overloaded. It smooths out the change from the intermittent receipt of material by grab or car to the continuous flow required in conveying. A good feeder is a labour saver.

Reciprocating feeders have been standardized in several types, jigging or shaking feeders that jerk the material along on a plate or pan, plunger feeders that push the material, and displacement pan feeders that are used for lumpy materials and greater capacities. All types are much used, as they are simple and not expensive, and they are easily adjustable to give close regulation to the material fed. While these feeders are sometimes used for high capacities it is not usual to design them for more than 200 tons of coal per hour.

The use of belt feeders overlaps that of the reciprocating feeders, but they are generally used for higher capacities. They have been standardized for capacities from 50 to 2,000 tons of coal per hour. In the smaller capacities they are generally more expensive than reciprocating feeders, but are capable of much closer measurement and regulation of the material. They are preferable to reciprocating feeders on an elevated structure or in a building because of freedom from vibration. A belt feeder takes a little more power than an equivalent reciprocating feeder, and its operating and maintenance costs are about the same.

Apron or pan feeders are steel conveyors and are made in several styles for different uses. They all, however, have aprons, pans, or plates, supported by chains running over sprocket wheels. For fuel handling, they do the same work as belt feeders, but are more expensive. Their advantage over belt feeders is that they can turn sharply and carry the material up a steeper incline. Power, operating, and maintenance costs, when handling coal, are about the same as those of belt feeders, but when handling coke the maintenance cost of chain conveyors is higher, also, breakdowns take longer to repair.

The screw or spiral conveyor is used for conveying horizontally fine dry non-abrasive materials, and is excellent for pulverized coal. For lumpy or wet sticky coal it is troublesome, and for coke the wear is rapid and maintenance cost excessive.

The chain-and-bucket machine, which elevates vertically and also conveys horizontally, is very useful. It is much used in power stations and gas works to elevate coal from the track hopper and distribute to any part of the bunker, and sometimes, do then run underneath the furnace on its return journey and bring out the ashes. Its use for handling ashes in power stations is declining, the latest practice being to do so only for a certain moderate-sized plant, below which the amount of ashes is too small to warrent placing so little of such an abrasive material in an expensive machine with numerous wearing parts, and above which size the amount of coal to be handled is too large to endanger the supply by maintenance repairs to chains worn by ashes dust.

Skip hoists are used to elevate material intermittently, discharging directly into an overhead bin or bunker. For ash disposal at power stations they are often used to raise the ashes, in the same hand-truck in which they are collected, or after being dumped into a permanent skip bucket, to the elevated loading bin. In such cases the hoisting, dumping, and returning, are consecutively automatic upon being started. Such installations are useful for small power stations, or gas works, to raise coal from beneath the track hopper to an overhead bin.

Their principal limitation is that, as their discharge is intermittent, it is difficult to distribute from them with a continuous conveyor. For simple elevation, without distribution at the top, an automatic skip hoist is the most efficient installation, for the least investment, for capacities between 60 and 150 tons per hour.

Conveyors may be divided conveniently into continuous conveyors and intermittent conveyors. The continuous conveyors may be divided again into those that push or pull their load, and those that actually carry the material. One disadvantage of the types of conveyors that push or pull material in a trough is that friction consumes power and causes wear. The carrier type is usually more economical. The belt conveyor has come to be considered the most efficient of the carrier types.

Screw or spiral conveyors, as mentioned under "Feeders," have a limited use handling certain fine materials. Although an inefficient pusher conveyor, there are occasions when they may be used to advantage distributing over short bunkers in small plants, where the coal is always small, and never wet or sticky, at capacities up to 30 tons per hour, and when low first cost is all-important. They occupy little headroom and distribute without attendance.

The use of the belt conveyor has become so general and widespread that it is in danger of abuse. It looks such a simple machine that it is difficult to realise that years of costly experience and development were necessary to bring it to its present state.

Belt conveyors for coal and coke should be of strong, rigid construction and of the troughed type. The design of the mechanical parts and supports of a belt conveyor greatly affects the life of the belt. When belt replacement costs are high, it is generally the fault of the installation and seldom the fault of good modern conveyor belting.

All the wear of the material carried should be taken by the rubber cover of the belt, and the canvas body should be considered only for tension and flexibility.

The principal advantages of belt conveyors are their simplicity, low first cost, and high efficiency. Their high capacity is a large factor in their high efficiency. Between 30 and 50 tons of coal per hour, transporting up to a distance of about 200 ft., a belt conveyor is well worth consideration. For higher capacities, up to 2,000 tons per hour, and increasing the distance with the capacity, up to a maximum of about 3,000 ft., it seldom has a competitor.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING

INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

High Pressures Draw Record Crowd to Philadelphia A.S.M.E. Meeting

Report on 1,400-lb. Holland Station Followed by Survey of Industrial High-Pressure Plants

WIDESPREAD interest in higher steam pressures was demonstrated by the attendance at the March 26 meeting of the Philadelphia Section of the A.S.M.E. Including visitors from New York City and other out-of-town points, more than four hundred gathered for the technical session in the Stephen Girard Hotel. The technical session was preceded by a dinner attended by two hundred engineers.

Two papers were presented. E. M. Gilbert, vice-president and chief engineer, W. F. Barstow & Company, Inc., reporting progress in the construction of the 1,400-lb. station at Holland, N. J., reviewed many novel features of the design and predicted a substantial saving in power cost, including all charges, in spite of the fact that the plant is not to be favored with a base load. P. W. Swain, associate editor of Power, presented a survey of industrial plants operating at pressures from 300 lb. to 1,800 lb. and outlined the economic fundamentals of high pressures as applied to industrial plants.

Progress at the Holland Station

The Holland station, as Mr. Gilbert pointed out, is designed for an ultimate capacity of 220,000 kw., with an initial unit of 55,000 kw. It is designed to operate at the regular system load factor and all refinements used have been required to justify themselves on this basis.

After study of 400-lb., 550-lb.-reheat, and 1,200-lb.-reheat cycles, the last was selected as the best investment, since it showed a considerable saving in fuel over the 400 and 550 lb. plants with a cost but little higher than the 400-lb. plant.

An abstract of Mr. Gilbert's paper, which followed in the main the lines laid down in an article in the February issue of the General Electric Review, will appear later in *Power*. It is therefore necessary to mention here only a few points of special interest.

In view of proposed operation at system load factor rather than as a base-load plant, the 1,200-lb. turbine has been especially designed to give a flat steam consumption curve. To meet this condition the manufacturer developed a special turbine with five valves.

The plant is provided with water walls, convection-type superheaters, first-stage steam reheater and a second stage gas reheater, economizer and air preheater. Much of the economy in first cost has come from a careful study of the proportioning of heating surface in water walls, boiler, superheater, economizer and air heater. The gas reheater is located in the boiler setting.

Pulverized coal is to be used. The burners are arranged for opposed firing, so that the flames will meet in the middle and keep excessive temperatures away from the walls, improve combustion, increase speed and thus reduce carbon losses and the danger of slag on the boiler tubes. Opposed firing will also enable anthracite and bituminous coal to be fired separately but thoroughly mixed during combustion.

Following experiences with other plants, the wall has been omitted between the turbine room and the boiler room and centralized operation from one point instituted.

The main feature of Mr. Swain's paper was an extensive table of industrial plants operating at pressures from 300 to 1,800 lb. This table shows over 60 plants in the range from 300 to 400 lb. and about the same number in the range from 400 to 600 lb. Four plants above 1,000-lb. pressure are listed and four in the range from 600 to 1,000 lb. It is planned to publish this table with revisions in the May 28th issue of *Power*.

Mr. Swain preceded his presentation of the table by a general discussion of the fundamental principles involved in the application of high pressures to industrial plants. This part of his paper will be reprinted in the April 9 issue of *Power*. A brief résumé follows:

In five years the academic interest in high steam pressures has become intensely practical as experimental and commercial installations have fully realized predicted economies, while troubles encountered have in the main been overcome. The term high pressure is relative and must be interpreted to mean pressure that is out of the ordinary for the given class of installations. Thus 300 lb. and up may be taken as high pressure in the industrial plant, while 500 or 600 lb. and up is high pressure in central-station work.

Confusion is likely to result from a blind attempt to apply the relative costs and economies of plants at various pressures, as computed for central station conditions, to industrial plants. It seems probable that few new central stations will be built in the range from 600 to 1,200 lb. The introduction of reheating around 500 or 600 lb., now considered necessary, causes a sharp jump in station cost. With further increase in pressure the cost falls off. Thus a 1,200-lb. plant costs less than a 600-lb. plant and saves more fuel. The choice then must generally lie between a 400-lb. plant and a 1,200-lb. plant.

The industrial plant with high back pressure does not require reheating at 600 lb. or even considerably higher presures. Thus the relation given for central stations does not hold, and an industrial plant may justify, in one case, no more than 200 lb., in another 400, in another 600, 800 and so on up to 2,000 lb. or more.

In large process plants, the main factor determining pressure is the ratio of power demand to process steam demand. When the pressure has been raised to a point where all desired power can be generated as a by-product, there is no object in further rise. This limit will vary widely with different classes of plants. Study of the Mollier chart shows clearly the much higher gain from high pressures, in power per pound of steam and per pound of fuel, with higher back pressures. Thus some industrial plants with high back pressures may justify pressures above 1,200.

Discussion

In the discussion of the papers of Messrs. Gilbert and Swain, R. J. S. Pigott asked whether thick superheater tubes might not give trouble at high temperatures. He felt that circulation difficulties had been overestimated and that most troubles were due to dirty water. Welded boiler drums may not be far off, Mr. Pigott suggested, pointing out that the absence of seams may solve the problem of caustic embrittlement. The proper design of valves for high pressures still calls for study in Mr. Pigott's opinion. Finally, he predicted that high presures will bring engineers squarely up against the problem of complete automatic regulation throughout the plant. He complimented Mr. Gilbert on the omission of the walls in the boiler room, pointing out that this had been done previously at the Toronto station. He agreed with Mr. Swain that industrial steam pressures are often fixed by the load.

A. C. Wood, consulting engineer of Philadelphia, recommended caution in jumping to high pressures in industrial plants. He felt that in many cases high pressures might not be warranted.

W. B. Flanders of the Westinghouse Company referred to Mr. Swain's paper as almost a textbook on the subject of high pressures in industrial plants. He

stated, however, that the pressures can now be raised to 600 lb. before reheating will become necessary. The manufacturers, said Mr. Flanders, are prepared to keep in step with the users in the matter of high pressures.

V. L. Sanderson of the Philadelphia office of the Terry Turbine Company, felt that most industrial plants are unwilling to pay the salary of the right kind of an engineer. He presented figures showing the increased cost of going from 400 lb. to 600 lb. pressure. Mr. Sanderson's discussion contained a number of points of special interest and it is planned to publish it briefly in an early number of *Power*.

W. E. S. Dyer, consulting engineer of Philadelphia, commented on several of his plants listed in the table. He showed how the 1,800-lb. pressure for the Philips Carey installation had been arrived at by figuring higher and higher pressures and more and more efficient units until a point was reached where practically all the power needed could be generated as a by-product. This plant will use reciprocating engines of foreign make.

Johns-Manville Elects New Officers

At a meeting of the board of directors of the Johns-Manville Corporation, held March 15th, William R. Seigle, formerly vice-president in charge of mines and factories, was elected chairman of the board of directors, and Lewis H. Brown, formerly secretary and assistant to the president, was elected president. Mr. Seigle succeeds Mr. H. E. Manville, resigned, and Mr. Brown succeeds Mr. T. F. Merseles, who died March 6.

Mr. Seigle has been in the services of Johns Manville since his graduation from college in 1900, at which time the corporation was known as the H. W. Johns Manufacturing Company. His technical training covered the fields of mechanical and electrical engineering, as well as electro-chemistry. His remarkable research and development abilities have been responsible for the development of many of the insulating, electrical and building materials upon which the company has based its substantial success. His greatest hobby today is his completely equipped private laboratory at his country home at Mamaroneck, New York, where he employs regularly a staff of chemists and in which he spends considerable of his own time.

Under Mr. Seigle's leadership the mines and factories making up the manufacturing units of Johns-Manville have been greatly enlarged and improved by the introduction of labor and time-saving devices. Many new plants have been built including the important factories located in Asbestos, Canada; Waukegan, Illinois; and Pittsburg, California.

Mr. Brown is a graduate of the University of Iowa, and for many years has been engaged in merchandising work for various companies. He was closely associated with T. F. Merseles when the latter was president of Montgomery-Ward & Company. Recognizing that in Lewis H. Brown he had developed an able executive with imagination, character and a remarkable ability to handle difficult organization problems, Mr. Merseles selected Mr. Brown to accompany him as his assistant when he became President of Johns-Manville in August, 1927.

Coming Conventions

American Boiler Manufacturers Association. Annual meeting, June 3-5, Sky Top Lodge, Cresco, Pa. A. C. Baker, secretary, 801 Rockefeller Blvd., Cleveland, O.

American Institute of Electrical Engineers, annual summer convention, Swampscott, Mass., June 24-28. Pacific Coast Regional Meeting, Santa Monica, Calif. Sept. 3-6. F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Institute of Refrigeration, at Washington, May 2, 3, 1929. Louis Baron, secretary, 203 West 13th St., New York City.

American Oil Burner Association, annual convention, Hotel Pennsylvania, New York City, April 9-11, 1929. For information, address the headquarters of the Association at 420 Madison Ave., New York City.

American Society of Heating and Ventilating Engineers, annual summer meeting, Big Wind Inn, Lake of Bays, Ontario, Can., June 27-29. A. V. Hutchinson, secretary, 29 W. 39th St., New York City.

American Society of Mechanical Engineers, spring meeting, Salt Lake City, Utah, July 1-4, 1929. Rochester regional spring meeting, Rochester, N. Y., week of May 13. Calvin Rice, secretary, 29 West 39th St., New York City.

American Welding Society, annual meeting to be held in New York City, April 24-26. Secretary M. M. Kelly, society headquarters, 33 West 39th St., New York City.

Association of Iron and Steel Electrical Engineers, 25th annual convention, Pittsburgh, Pa., June 17-22, 1929. A. A. Stewart, secretary, Pittsburgh Steel Co., Monnessen, Pa.

Canadian Electrical Association, annual convention, to be held June 19-21, at St. Andrews-by-the-Sea, N. B. H. M. Lyster, secretary, Power Building, Montreal, Que.

Master Boiler Makers Association, at Atlanta, Ga., May 21-24. H. D. Vought, secretary, 26 Cortlandt St., New York City.

National Association of Power Engineers, 47th annual convention, Chattanooga, Tenn., Sept. 9-13. Fred Raven, secretary, 417 South Dearborn St., Chicago, Ill.

National Electric Light Association. Annual meeting at Atlantic City, N. J., June 3-7. A. J. Marshall, secretary, 420 Lexington Ave., New York City.

National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York City, Dec. 2-7. Charles F. Roth, manager, Grand Central Palace, New York City.

National Oil and Gas Power Meeting. Under auspices of A.S.M.E. Oil and Gas Power Division and the Pennsylvania State College. June 24-27, State College, Pa. F. G. Hechler, chairman, State College, Pa.

World Engineering Conference. Tokyo, Japan, October, 1929. All correspondence should be addressed to the Secretary, World Engineering Conference, Nikon, Kogyo Club, Morunouchi, Tokyo.

Fiftieth Anniversary of Electric Light to be Celebrated This Year

An event known as "Light's Golden Jubilee" will be held during the coming summer and fall, according to information released by a special committee of engineers and others identified with the electric light business. The jubilee will have its culmination upon Oct. 21, the fiftieth anniversary of the day upon which Thomas A. Edison completed his first successful experimental lamp.

The suggestion for the jubilee was first made on the occasion of Edison's 82nd birthday, at a luncheon of the Edison Pioneers, the plan being proposed by John W. Lieb, vice president of the New York Edison Company. It is expected that plans for the celebration will be completed and ready for presentation at the annual convention of the National Electric Light Association at Atlantic City in June. Celebrations both local and national in character are expected to follow throughout the summer and fall.

Six-State Colorado Compact Has Been Ratified

With the signature last week by the Governor of Utah on the act of the Utah Legislature ratifying the Boulder Dam bill, the last of the necessary six states approved the measure. When Congress passed the bill and it was signed by President Coolidge on Dec. 21 last, a six months' period was allowed for its ratification by the seven states directly involved or, if Arizona persisted in its refusal to come into the compact, then ratification by six other states, including California, was to be sufficient. Arizona, therefore, has until June 21 next for ratification.

After the lapse of the stipulated time and before construction of the dam can begin it is necessary for the Secretary of the Interior to make contracts for power and water sales sufficient to return the cost of construction plus 4 per cent interest. Thus there is much to be done before construction can start, even under the most favorable conditions.

Benzine in Sewer Causes Boiler Room Explosion

A severe explosion in the boiler room of the City Laundry, Akron, Ohio, recently, caused by blowing off a boiler into the city sewer, resulted in the death of the fireman who was in charge of the plant at the time.

It was evident that some time during the day a quantity of benzine, which had been used in dry cleaning, had found its way into the sewer. There were several openings from the sewer into the building, but each was protected by a trap and water seal.

The boilers, instead of being connected to an expansion tank before emtying into the sewer, were connected direct. The steam pressure at the time

was about 100 lb. and was sufficiently high to cause the benzine fumes to back up through the traps into the boiler room, where they were ignited.

The fireman went to the rear of the boilers to blow one of them down and the blow-off valve had been open but a few seconds when the explosion occurred. He was hurled against the back of the boiler with such force that this together with the severe burns that he received caused his death a few hours later. Large doors in the front of the boiler room were open at the time and this reduced the force of the explosion so there was little damage to the equipment.

80,000-Hp. Turbines Ordered for Russian Government

An order for four hydraulic turbines and generators, said to be the largest ever constructed, has been placed with the Newport News Shipbuilding & Dry Dock Company and the International General Electric Company by the Soviet government of Russia. The turbines are for the hydro-electric plant now under construction on the Dnieper River.

The four hydraulic turbines are to be of 80,000 hp. each, direct connected to four vertical electric generators of 77,500 kva. each. The plant eventually will contain ten such units.

Hugh L. Cooper, New York, is consulting engineer on the project. A. V. Winter is chief engineer.

New Steam Plant for Oklahoma Gas & Electric

A new electric plant, to be called the Lincoln Beerbower Generating Station, will be built by the Oklahoma Gas and Electric Company, a subsidiary of Standard Gas and Electric Company, on the Arkansas River near White Eagle, Oklahoma, according to an announcement by Halford Erickson, vice-president, H. M. Byllesby & Company.

Initial generating capacity of the station will be 15,000 kilowatts. Construction work will begin immediately and a year will be required to complete it.

It is understood that equipment has already been ordered and all of the land secured in connection with the site. The original installation will burn petroleum coke. When this is not available, powdered coal will be substituted.

With the completion of the new Lincoln Beerbower station the total generating capacity in the Oklahoma Gas & Electric system will be 159,260 kws.

NAPE Connecticut Convention

The Connecticut State Association of the National Association of Power Engineers are arranging to hold their Annual Convention in Bridgeport, Conn., June 21-22. It is planned to hold the usual mechanical exhibition in connection with the convention. Information regarding both may be obtained from Wilbur Foster, secretary, 400 Willow St., Bridgeport, Conn.

*Spot * News*

GOVERNOR ROOSEVELT'S BILL, *proposing the creation of a body of citizens, to be known as the Trustees of the Resources on the St. Lawrence, was defeated last week in the New York State legislation mill. This action was to be expected, since somewhat similar bills proposed by Governor Smith have repeatedly met with the same fate. The proposed legislation was to develop the water-power of the state under the control of a board of trustees so that their ownership should always remain vested in the people of the state.*

* * *

ONE NEW INDUSTRY *every three days was located in cities and towns in the Piedmont Carolinas section served by the Duke Power Company, during 1928. Thirty different types of manufacturing were represented.*

* * *

ONE HUNDRED AND SEVEN *food manufacturers in the Cleveland industrial area, who turn out products valued at $100,000,000 annually, the U. S. Department of Commerce reports, spend only ½ cent of their purchasing dollar on electric power and light.*

* * *

LANSING, MICH., *has again found it necessary to enlarge its municipal power plant with an extension that will include a 20,000-kw. turbine with the necessary boilers and equipment.*

* * *

A BUDGET *of $68,700,000 has been announced by the New York Edison Company for 1929. This amount, according to president Sloan, is several million dollars less than it would have been before the consolidation of the five companies serving the metropolitan area.*

* * *

A CANADIAN REPORT *on the January power consumption shows that 28,920,000 kw.-hr. was generated by fuel, an increase of 50 per cent over the figure for the previous January. However, this is somewhat less than two per cent of the total central-station-generated output for the month, the remainder being hydro power.*

* * *

THE FISH RIVER *in northeastern Maine is to be included in a large paper-mill project to be undertaken by the International Paper Company. A 20,000-hp. hydro-electric development will be made on the river, which is part of the watershed supplying the Grand Falls development in New Brunswick.*

Canada Plans $2,000,000 Research Laboratory

Tenders will be called shortly for the construction of the new national research laboratory at a cost of not less than $2,000,000, it was announced recently by Dr. H. M. Tory, president of the National Research Council. Plans of the laboratory have already been approved and construction operations are expected to start by May 1st and to be completed by September 30th, 1930. In addition to being equipped with research laboratories for industrial chemistry, engineering physics, industrial engineering, textiles and economic biology, provision is also made for the study of methods improving the processes of manufacture and for the solution of special problems arising from the development of the natural resources of Canada.

Federal Power Commission Applications

The City of Tacoma has applied to the Federal Power Commission for a preliminary permit looking to a future step in its plan of municipal development. The application covers a site on the South Fork of the Skokomish River, 15 miles northwest of Shelton, where it is proposed to construct a masonry arch dam 280 ft. high and an earthern dyke to form a storage reservoir with an area of 1,800 acres. From this reservoir it is planned to drive a tunnel three and one-half miles long to connect with Cushman reservoir No. 1, now a part of the applicant's system. The water, thus added to the Cushman reservoir, will be utilized through existing and prospective power houses. The new site is expected to develop 39,100 hp.

James B. Girand, of Phoenix, Ariz., has applied for preliminary permits covering two additional sites on Salt River. This, with his previous application, will completely develop the resources of that stream. One of the new applications proposes the construction of a dam 325 ft. high just below the junction with Carrizo Creek. At that point 14,000 hp. will be developed, it is estimated. A second dam three miles down stream from the Carrizo site will be 140 ft. high, where 9,000 additional horsepower can be developed. The second application covers a dam 200 ft. high just above the mouth of Soldier Creek. This site will require the construction of a tunnel 49,000 feet long diverting the water ten miles downstream. In this way an additional 8,000 hp. can be developed. The power is for the use of the copper mines of Southern Arizona.

PERSONALS

A. A. JOHNSON and FREDERICK WIERK, until recently with the consulting organization of Karl A. Lefren at 171 Madison Ave., have recently established a new consulting firm. This

concern will be known as Johnson & Wierk, and will be located in the Grand Central Terminal Building, New York City. The new firm will engage in a general consulting practice on steam, hydraulic and electric power-houses and various industrial problems, such as equipment and building layouts.

A. D. SKINNER, President of the Skinner Engine Company, Erie, Pa., is now abroad and expects to return to this country about the middle of April.

WM. CLINTON BROWN, managing director of the Stumpf Uniflow Engine Company, Inc., accompanied by Mrs. Brown, is passing a few weeks at Stuart, Fla.

FREDERICK A. SCHEFFLER, of the Fuller-Lehigh Co., has just returned from a trip through the South as far as Havana. Mrs. Scheffler accompanied him.

R. A. SHILBAUER, formerly assistant advertising manager of the Chain Belt Company, Milwaukee, Wis., has been promoted to the position of advertising manager of that company.

S. H. KENNEDY of Chattanooga, Tenn., has formed an engineering contracting firm to be known as the S. H. Kennedy Co., to engage in general power plant and industrial building contracting

BUSINESS NOTES

THE DAYTON-DOWD COMPANY has appointed D. C. Elphinstone, Incorporated, 120 South Calvert St., Baltimore, Maryland, as their district representative.

THE ROLLER-SMITH COMPANY has made two additions to its sales organization; J. Brown, Jr., Kittridge Building, Denver, Col., and in the Philippine Islands, The Manila Machinery and Supply Company, Incorporated, of Manila.

THE READING IRON COMPANY, of Reading, Pa., reports the establishment of a new district sales office at 1216 Hibernis Bank Building, New Orleans, La.

THE READING IRON COMPANY, Reading, Pa., reports the choice of E. W. McHenry as district sales representative to be located at Houston, Texas.

K. G. BAKER has joined the sales force of the Wagner Electric Corporation, Cincinnati, Ohio.

D. S. WALKER was elected vice-president of D. H. Skeen and Company at the last stockholders' meeting of the company.

J. S. WATSON is announced by the executive offices of the Link-Belt Company, to have been made vice-president, with headquarters at the company's Dodge Works at Indianapolis, Ind.

B. E. HOVIND and S. T. WEAVER have been added to the representative staff of the Chicago Belt Company, Chicago, Ill.

With the Society Sections

A. S. M. E., Metropolitan Section. Meeting April 11, Fuels Division, Subject: "The Heat Balance as a Means of Determining Evaporating Efficiencies of Steam Generating Equipment," by B. J. Cross, Combustion Engineering Corp. Meeting April 19, Division of Applied Mechanics, Subject: "Crankless Reciprocating Engines and Pumps," by A. G. M. Michell, Michell-Crankless Engine Corp. Meeting April 24, Oil and Gas Power Division, Subject: "Diesel Power Plants for Large Buildings," by Edgar J. Kates, Consulting Engineer. Meeting April 29, Power Division, Subject: "The Modern Marine Power Plant," by W. Flanders and P. Lamb.

American Water Works Association, Montana Section. Annual convention, to be held April 4 and 5 at Great Falls, Mont.

American Water Works Association, Florida Section. Meeting, April 10, at Jacksonville, Fla. Subject to be announced later.

Engineers Club of St. Louis. Meeting April 10. Subject: "Pumps and Pumping," by A. T. Hunter, De Laval Steam Turbine Company.

Second Annual Indiana Fuel Conference, at Purdue University, Lafayette, Ind., April 4-5.

TRADE CATALOGS

BEARINGS — The latest publication issued by the Timken Roller Bearing Company, of Canton, Ohio, is a 150-page leatherette-covered book, covering not only the general subject of the application of Timken Bearings to all sorts of automotive, railway and industrial equipment in detail, but also technical information on bearing mountings and installations. There is a long table giving detailed information of the Timken Bearings grouped by cone bores, and another giving series number, dimension and price list of the bearings. It contains photographs, line drawings, copies of blueprints, and photographs of testimonial letters throughout.

FLUE GAS ANALYZER—The Hays Corporation, Michigan City, Ind., has issued a new 16-page catalog dealing with Hays flue gas analyzers and portable combustion test sets. The new publication outlines what an analysis actually shows, and comments on the Hays features of construction. Portable combustion test sets include a three-chamber gas analyzer, inclined-tube draft gage, manometers or *U* tubes, a thermo-gage and flue gas thermometer.

COMBUSTION SYSTEM—Foltz Furnace Company, 431 S. Dearborn St., Chicago, has just issued an attractive 56-page catalog dealing with the company's method of preheating a portion of the combustion air by means of ducts in the side walls and introducing this air over the fire near the front of the furnace. Improved combustion, greater capacity, cleaner fires and smokeless operation are some of the claims for the system that have been demonstrated in a large number of installations. In the new publication the principles of combustion are discussed, and space given to a variety of Foltz installations and the results obtained therefrom.

A-C AUTOMATIC STARTERS — The Monitor Controller Company, Baltimore, Md., is sending out on request its eight-page bulletin No. 113, describing the company's new starters for alternating-current squirrel-cage motors. This starter has a new type of thermal timing device, which controls the accelerating-contactors operation.

SELF-LOCKING BOLTS—The Dardelet Threadlock Corporation, New York City, has published an eight-page booklet called "The Challenge to Vibration," describing its tapered thread bolts embodying a self-locking feature.

FUEL PRICES

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.35@$2.40
Kanawha	Columbus	1.25@1.06
Smokeless	Cincinnati	2.15@ 2.25
Smokeless	Chicago	1.75@ 2.25
S. E. Kentucky	Chicago	1.35@ 1.60
Steam	Pittsburgh	1.55@ 1.75
Gas Slack	Pittsburgh	1.00@ 1.15
Big Seam	Birmingham	1.25@ 1.50
Anthracite (Gross Tons)		
Buckwheat	New York	$2.75@$3.00
Barley	New York	1.00@ 1.50

FUEL OIL

New York—Mar. 21, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75c. per gal.; 36@40 deg., furnace, tank-car lots, 6.25c. per gal.

St. Louis—Mar. 21, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.40 per bbl. or 42 gal.; 26@28 deg., $1.45 per bbl.; 28@30 deg., $1.50 per bbl.; 30@32 deg., $1.55 per bbl.; 32@36 deg., gas oil, 4.78c. per gal.; 38@40 deg., distillate, 5.75c.

Pittsburgh—Mar. 19, f.o.b. local refinery, 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., 5.25c. per gal.

Philadelphia—Mar. 21, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 22 deg. plus, $1.47@$1.53 per bbl.; 23@27 deg., $2.10@$2.16 per bbl.

Cincinnati—Mar. 29, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.95c. per gal.

Chicago—Mar. 22, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 70c. per bbl.; 26@30 deg., 90c. per bbl.; 30@32 deg., $1.20 per bbl.

Boston—Mar. 25, tank-car lots, f.o.b. 12@14 deg Baumé, 4.54c. per gal.; 28@32 deg., 5.62c. per gal.

Dallas—Mar. 23, f.o.b. local refinery, 26@30 deg., $1.25 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Colo., Denver—City and County awarded contract for the construction of a court house including boiler house on Brunswick between West 14th and 15th Aves., to Varnum & Bate, 2311 10th St. Estimated cost $4,500,000.

Colo., Pueblo — Colorado Interstate Gas Co., Denver, plans the construction of a natural gas booster station near here. Estimated cost $600,000. Ford, Bacon & Davis, 39 Broadway, New York, N. Y., are engineers.

Colo., Salida — Public Service Co. of Colorado, Denver, plans the construction of a hydro-electric development on Foose Creek. Plans include two dams, one 20 ft. high, 100 ft. long and one 10 ft. high, 50 ft. long, also power generating equipment, transmission lines, etc. Estimated cost $95,000.

Ind., East Chicago—City will soon award contract for waterworks improvements, including pumping station, mains, etc. Estimated cost $40,000. Pearse, Greeley & Hansen, 6 North Michigan Ave., are engineers.

Kentucky — Kentucky Electric Development Co. Inc., Breslin Bldg., Louisville, plans the construction of two small hydro-electric power plants, one located at Cascades of Bronston in Pulaski county and the other at Mill Springs in Wayne county. Estimated total cost $100,000.

Ky., Louisville — Synodical Presbyterian Orphanage of Southern Church, R. Haney, Supt., Anchorage, Ky., is having plans prepared for a group of buildings, including power plant, etc., here. Estimated cost $200,000. Nevin, Wischmeyer & Morgan, Starks Bldg., Louisville, are architects.

Mass., Bridgewater — Bd. of Education, State House, received lowest bid for rebuilding power plant at State Normal School from F. Losordo & Co., 24 School St., Boston. Estimated cost $80,000. J. R. Worcester Co., 70 Milk St., Boston, is engineer.

Mass., Cambridge (Boston P. O.)—Boston Elevated Railway Co., Park Sq. Bldg., Boston, awarded contract for the construction of a sub-station at Boylston and Elliot Sts., here, to E. E. Munroe, 536 Harrison Ave., Boston.

Mass., Woburn — Edison Electric Illuminating Co., 39 Boylston St., Boston, plans the construction of a transformer station here. Estimated cost $500,000. Engineer not announced.

Mich., Detroit—Detroit Edison Co., 2000 Second Blvd., is having plans prepared for the construction of a sub-station at Rivard and Trombly Sts. Estimated cost $850,000. Private plans.

N. J., Jersey City — Owner, c/o P. Simeone & Co., Inc., 22 Journal Sq., Archts. and Engrs., will receive bids about Apr. 15 for the construction of a 65 x 100 ft. power house, including 500 hp. boiler and 600 kw. engine, etc. Estimated cost $150,000.

N. Y, Conklinville — Mohawk Hudson Power Corp., 126 State St., Albany, will soon receive bids for the construction of a new power house here. Estimated cost $700,000.

N. Y., New York — Bd. of Transportation, J. H. Delaney, Chn., 49 Lafayette St., will receive bids until Apr. 5, for the construction of sub-stations, 2 and 3 in connection with Rapid Transit Railroad.

N. Y., New York—New York Edison Co., M. S. Sloan, Pres., 130 East 15th St., plans an expenditure of $68,700,000 during 1929. Plans include new construction at present generating stations, new power plant equipment and increasing capacity of present equipment, $20,000,000; completion of extension to East River station and increasing boiler capacity, East River and 14th St. $6,750,000; new boilers and remodeling existing boilers at Hell Gate Station, $5,000,000; new sub-stations and enlarging existing sub-stations. $5,000,000; 132,000 v. transmission line from Hell Gate station to Dunwoodie sub-station $1,185,000.

O., East Cleveland — Cleveland Union Terminal Co., Terminal Tower, Cleveland, awarded contract for the construction of an 82 x 86 ft. generator station at 1975 Hayden Ave., here, to Hunkin-Conkey Construction Co., Newman-Stern Bldg., Cleveland. Estimated cost $175,000.

O., Tippecanoe City—City plans an election May 14, to vote $100,000 bonds for addition to municipal electric power and water pumping plant.

Okla., Ponca City — Oklahoma Gas & Electric Co., Insurance Bldg., Oklahoma City, is having preliminary plans prepared for the construction of a 15,000 kw. steam power plant near here. Estimated cost $100,000. Byllesby Engineering Co., 231 South La Salle St., Chicago, Ill., is engineer.

Ore., Joseph—Pacific Power & Light Co., G. W. Talbot, Pres., Gasco Bldg., Portland, is having plans prepared for the construction of a new power plant on Wallowa Lake here. Estimated cost to exceed $200,000. H. H. Schoolfield is chief engineer.

Pa., Middletown—Odd Fellows Home of Pennsylvania, plans the construction of a 50 x 50 ft. power plant. W. H. Lee, 1505 Race St., Philadelphia, is architect.

Pa., New Castle — Pennsylvania Power Co., Sharon, c/o Stevens & Wood, 20 Pine St., New York, N. Y., Engrs., will build an outdoor sub-station here. Estimated cost $200,000. Work will be done by day labor.

Tex., Fentress—Central Power & Light Co., Frost Bldg., San Antonio, have acquired the electric plant of Fentress Gin & Power Co., and plans the construction of a sub-station here. Estimated cost $30,000.

Tex., Fort Worth — Missouri, Kansas-Texas R.R., St. Louis, Mo., awarded contract for the construction of a coast yard supply building, store and oil building, power house, etc., here. F. Ringer is chief engineer.

Ont., Toronto — Western Hospital, 391 Bathurst St., plans the construction of a hospital, including central heating plant at Bathurst St. Estimated cost $3,000,000. Architect not selected.

Equipment Wanted

Boiler Room Equipment, Compressor, etc.—Sterling Glass Co., Lapel, Ind., plans the installation of new boiler room equipment, compressor and other equipment. Estimated cost $30,000.

Boilers, Compressor, etc.—Water & Light Dept., C. E. Evans, City Comr., 414 West First St., Duluth, Minn., will receive bids until Apr. 12 for two new boilers, compressor, etc. Estimated cost $50,000.

Electric Light Plant Equipment—City of Sioux Falls, S. D., plans an election Apr. 16 to vote $100,000 bonds for electric light plant equipment.

Generators — Electrical Engineers Ltd., Calgary, Alta., is in the market for a 250 kw., 3 ph., 60 cycle 440 or 550 v. electric generator and 150 kw., 3 ph., 60 cycle 2,300 v., 125 lb. pressure steam engine generator set.

Ice Making Equipment — San Antonio Public Service Co., St. Marys St., San Antonio, Tex., plans the installation of new ice making equipment in recently acquired plant. Estimated cost $35,000.

Pump and Motor—Caruthers Union High School Dist., J. G. Gallagher, Secy., Caruthers, Calif., will receive bids until Apr. 8 for furnishing and installing a deep well pump and 7½ hp. motor.

Pump and Motor — County Sanitation Dist. 2, A. S. Soule, Secy., Los Angeles, Calif., will receive bids until Apr. 10 for a horizontal centrifugal water pump and horizontal centrifugal sewage pump with motors for proposed sewage treatment plant.

Pumping Equipment — D. C. Commissioners, Washington, D. C., will receive bids until Apr. 10 for pumping equipment for Sewer Dept.

Pumping Unit—City of Mt. Calm, Tex., pumping unit, etc., for proposed waterworks improvements. Estimated cost $40,000.

Pumping Unit—City of Dimmitt, Tex., pumping unit, etc., for proposed waterworks system. Estimated cost $35,000.

Turbine, etc.—Pacific Mills, Ltd., Ocean Falls, B. C., plans to purchase and install additional equipment including steam turbine, etc., for proposed improvements to pulp and paper mill.

Industrial Projects

Calif., Escondido—PACKING PLANT—Escondido Lemon Assn., will build a 1 story, 150 x 160 ft. packing plant at Tulip St. Estimated cost $140,000. J. R. Murray, 1213 University Ave., San Diego, is architect. Conveying equipment will be required.

Colo., Colorado Springs — FILM LABORATORY, SERVICE BUILDING, etc.—Alexander Industries, Inc., plans the construction of a 2 story, 75 x 305 ft. laboratory, service building, office, etc. Estimated cost $250,000. Parry & Jones, C. A. Johnson Bldg., Denver, is architect.

Conn., Bridgeport—BRASS FACTORY—Bridgeport Brass Co., R. Day, Gen. Mgr., will soon award contract for a 1 story, 75 x 200 ft. factory on Housatonic Ave. Estimated cost $100,000. Fletcher-Thompson Inc., 542 Fairfield Ave., is architect.

Conn., Hartford—SERVICE BUILDING—Hartford Electric Light Co., S. Ferguson, Pres., will soon award contract for a 4 story, 160 x 180 ft. service building on Sheldon St. Estimated cost $400,000. Smith & Bassett, 36 Pearl St., Hartford, Conn., are architects. E. W. Wiggin, 113 Church St., New Haven, is engineer.

Md., Baltimore—AIRCRAFT FACTORY—G. L. Martin Co., Colgate, will soon award contract for a 1 story, 302 x 903 ft. factory here. Estimated cost $1,500,000. P. L. Samall & Associates, 1836 Euclid Ave., Cleveland, O., are architects.

Mich., Battle Creek—SERVICE BUILDING—Consumers Power Co., Jackson, will receive bids until Apr. 6 for a 3 story, 76 x 96 ft. service building on South Jefferson St. Estimated cost $250,000.

Mich., Detroit — FOUNDRY — Cadillac Motor Car Co., Clark Ave., is having plans prepared for a 2 story addition to foundry. Estimated cost $340,000. A. Kahn, 1000 Marquette Bldg. Equipment will be required.

Mich., Detroit — SMELTING PLANT—Michigan Smelting & Refining Co., 7885 Joseph Campau Ave., awarded contract for a 1 story, 150 x 300 ft. addition to smelting plant to Krieghoff Co., 6601 French Rd. Estimated cost $125,000. Electric motors and equipment will be required.

Mich., Flint—CARBURETOR FACTORY—Marvel Carburetor Co., awarded contract for a 1 story addition to factory to W. E. Wood Co., 1805 Ford Bldg. Estimated cost $55,000. Electric motors, etc., will be required.

Mich., Lansing — AUTOMOBILE FACTORY—Olds Motor Works, 1101 Division St., is receiving bids for a 1 story, 180 x 500 ft. factory. H. E. Beyster, General Motors Bldg., Detroit, is engineer. Electric motors and equipment for the manufacture of auto body and motor parts of sheet metal will be required.

O., Cleveland—AUTOMOBILE and AIRPLANE PARTS FACTORY — Thompson Products Co., C. E. Thompson, Pres., 2196 Clarkwood Rd., awarded contract for a 4 story, 72 x 106 ft. addition to factory to DeHamel Construction Co., Plymouth Bldg. Estimated cost $150,000.

Okla., Tulsa — STEEL BARREL FACTORY—Wackman Welded Ware Co., 7th and Victor Sts., St. Louis, is having preliminary plans prepared for the construction of a steel barrel factory here. Estimated cost $100,000.

Pa., Sharon — SERVICE BUILDING—Pennsylvania Power Co. is having plans prepared for a 2 story service building. Estimated cost $100,000. Stevens & Wood, Inc., 20 Pine St., New York, N. Y., are engineers.

Tex., San Antonio—OIL REFINERY—Grayburg Oil Co., c/o S. M. Newton, Pres., Maverick Bldg., have acquired a 280 acre site and plans the construction of an oil refinery. Estimated cost $2,000,000. Private plans.